# THE BULLETIN

OF THE

## AMERICAN CERAMIC SOCIETY

Volume 19 AUGUST, 1940 Number 8

LEWIS PAUL REESE

For story, see page 302

# *Want to borrow a*

# LONG, GRAY BEARD?

**Our technologists say it's very useful in solving production problems**

If you go to our research laboratory in Washington, Pa., you'll find a group of highly skilled technologists surrounded by all the modern scientific equipment you can imagine.

They keep looking for facts about Drakenfeld colors and chemicals that will make your production easier, more economical. They have a keen scientific curiosity about new processes, new materials, new advancements in the ceramic industry.

But every once in a while a problem comes up that calls for something *more* than laboratory knowledge.

When that happens, they like to don the long, gray beard of experience we've grown during our seventy years of service to the industry.

It represents a past that has been filled with rich, down-to-earth experience in the field. It represents the sort of Science that wears overalls and likes to see how things work out in actual production.

Have you a problem involving the use of colors or chemicals? Drakenfeld technologists can give you the latest findings of research—*backed up by practical experience and interpreted in terms of your own specific needs.* They'll be glad to help without obligation. Just write.

*Oxide Colors • Body, Slip and Glaze Stains • Overglaze and Underglaze Colors • Squeegee Oils and Mediums • Gold, Silver, Platinum and Lustre Preparations • Metallic Oxides and Chemicals • Supplies.*

ESTABLISHED 1869

## B. F. DRAKENFELD & COMPANY, INC.

45-47 PARK PLACE · NEW YORK, N. Y.

WORKS: WASHINGTON, PA.

BRANCHES
East Liverpool, Ohio • Chicago, Ill.

PACIFIC COAST AGENTS
Braun Corp., Los Angeles • Braun-Knecht-Heimann Co., San Francisco

# THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

**Volume 19** **Contents for August, 1940** **Number 8**


## PAPERS AND DISCUSSIONS


Symposium on "Substitution of American for Imported Clays in Whiteware Bodies".....281–90
- Introduction to Symposium—Arthur S. Watts..... 281
- Properties of American Kaolins and English China Clays (Discussion)—T. A. Klinefelter..... 282
- Discussion on Norton Studies..... 284
- Discussion on Sproat Studies..... 284
- American Ceramic Materials in Pottery (Discussion)—Hewitt Wilson and Ernest Wilson..... 285
- An All-American Hotel China Body—G. A. Loomis and W. H. Earhart..... 287
- Substitution of Domestic Clays for Imported Clays in Electrical Porcelain Bodies—L. E. Thiess..... 289

Scratching of Glass by Metals—L. G. Ghering and J. C. Turnbull..... 290

Economies of Combustion Control in Industrial Ceramics—R. C. Hutchison..... 295

Refractories Used in High-Frequency Electric Melting of Steel and Alloys—B. W. Magalis..... 298

A Laboratory Course in Refractories—Nelson W. Taylor..... 315

The Ceramic Extension Program of The Pennsylvania State College—Edward P. McNamara..... 318

**Advertisers' Index**..... 6

**Buyers' Guide**.....12, 18, 20, 22


## INDEX OF CERAMIC HISTORY, ACTIVITIES, NOTES


**American Ceramic Society,** Financial Statement, 1939, graph, p. 309.

**American Society for Testing Materials,** 43rd annual meeting, p. 315; 1941 meeting, p. 315.

**Baltimore Meeting.** See Meetings, American Ceramic Society.

**Beekman, M. H.,** biog., photo, p. 312.

**Bibliographies,** glass manufacture, p. 315.

**Cavanaugh, D. J.,** paper on brick manganese in buff-firing clays, p. 315.

**Ceramic art** for occupational therapy, photos of equipment, p. 314.

**Ceramic engineers,** Indiana recognition, p. 314.

**Ceramic extension program** of Penn State, p. 318.

**Ceramic history,** Reese, L. P., p. 302.

**Corporation Members,** Roster, p. 310.

**Divisions,** Autumn Meeting dates, p. 321.
Enamel, Rules, proposed, p. 306.
Official Personnel, p. 322.

**Enamel Division,** Rules, proposed, p. 306.

**Financial Statement,** American Ceramic Society, 1939, graph, p. 309.

**Foote-Prints,** papers by Gillett, H. W., and Cavanaugh, D. J., p. 315.

**Gillett, H. W.,** paper on ductile zirconium and titanium, p. 315.

**Glass,** bibliographies, 1938–1939, p. 315.

**Glass Division,** Autumn Meeting, p. 321.

**Institute of Ceramic Engineers,** book list, p. 313; Indiana recognition of ceramic engineers, p. 314.

**Mallory, J. M.,** biog., photo, pp. 312–13.

**Materials and Equipment Division,** Autumn Meeting, p. 321.

**McNamara, E. P.,** ceramic extension program of Penn State, p. 318.

**Meetings,** American Ceramic Society, Baltimore Meeting: Walters Art Gallery, old Bow porcelain, p. 304.

**Members,** Corporation, paid, roster, p. 310.
new for July, p. 312.
paid membership record, p. 309.

**Necrology,** Beekman, M. H., biog., photo, p. 312.
Mallory, J. M., biog., photo, pp. 312–13.

**Norton Company,** Clark, H. K., and Holmstrom, A. B., new officers, p. 321.

**Pennsylvania State College.** See Schools.

**Photographs,** Beekman, M. H., p. 312.
Mallory, J. M., p. 313.
Phipps Clinic ceramic equipment, p. 314.
porcelain, old Bow, pp. 304–306.
Reese, L. P., August cover.

**Photographs** (*continued*)
Russell, W. H., p. 314.
Williams, Leighton, p. 314.

**Porcelain,** old Bow, in Walters Art Gallery, p. 304.

**Reese, L. P.,** photo, August cover; biog., p. 302.

**Refractories,** laboratory course at Penn State, outline, p. 315.

**Refractories Division,** Autumn Meeting, p. 321.

**Rules of Enamel Division,** proposed, p. 306.

**Rutgers University.** See *Schools.*

**Schools,** Pennsylvania State College, ceramic extension program, p. 318; laboratory course in refractories, p. 315.
Rutgers University, degrees in Ceramics, 1940, p. 314.

**Scio-Ohio Pottery Company** and biog. of L. P. Reese, p. 302.

**Taylor, N. W.,** laboratory course in refractories, p. 315.

**Union Internationale de Chimie publications,** p. 314.

**Walters Art Gallery,** old Bow porcelain, p. 304.

**White Wares Division,** Autumn Meetings, p. 321.

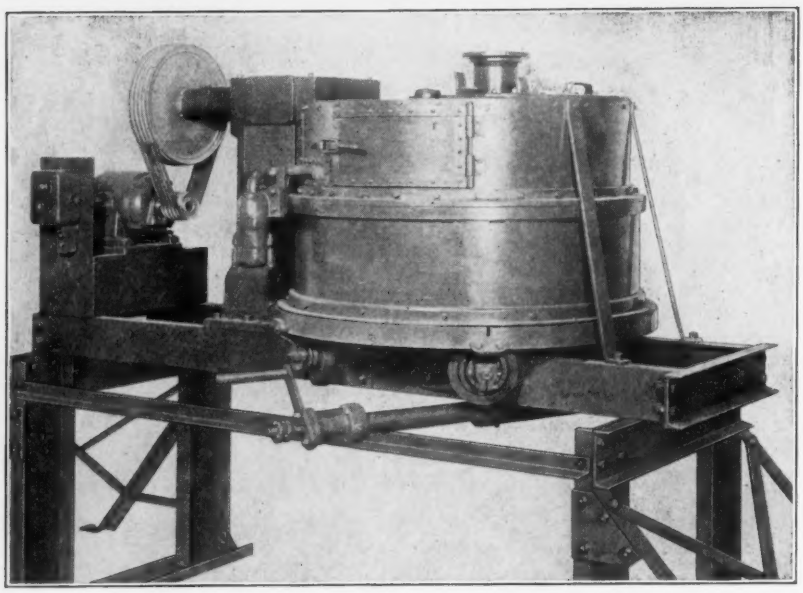


*Publication Office:* 20th & Northampton Sts., Easton, Pa.
*Editorial, Executive, and Advertising Offices:* 2525 N. High St., Columbus, Ohio.
*Committee on Publications:* J. D. SULLIVAN, *Chairman;* E. E. MARBAKER, J. B. AUSTIN, A. N. FINN, ROSS C. PURDY.

Entered as second-class matter at the post office at Easton, Pa., under the act of March 3, 1879. Published monthly.
Subscription $1.50 a year. Single numbers twenty-five cents.
*(Foreign and Canadian postage, 50¢ additional on subscriptions)*


*(Copyright 1940, American Ceramic Society, Inc.)*

# Lancaster



*A Self-Contained Fully Enclosed "Lancaster" Mixer*

## Lancaster Mixers

### WORTH THE INVESTMENT EVERY TIME

In their application to a broad range of Industry, including Ceramics, Refractories, Glass, Vitreous Enamels, Abrasives, Welding Rod Fluxes, Graphite Products, Powdered Metal Compounds and others, "Lancaster" Mixers are providing all the advantages which modern mixing implies.

The quality of products is improved, labor productivity is increased, body formulas are rigidly controlled, and production simplified.

In the "Lancaster" Mixer, the principles of batch movement and applied mixing intensity have been scientifically worked out to provide accurate and uniform processing.

In addition, the "Lancaster" Mixer is a triumph in design and construction because its scientific mixing principles keep maintenance and operating costs down to a minimum. The entire mechanism, employing cut gears and ball or roller bearings throughout, is mounted above the machine sills—out of the way of dirt. Special wear resistant metals are employed for the mixing elements.

Where dust control is a factor the facilities of "Lancaster" closed-pan units are unsurpassed in effectiveness.

Even under the most intensive production schedules the dependability and stamina of "Lancaster" Mixers are worth the investment every time.

**LANCASTER IRON WORKS, INC.**
BRICK MACHINERY DIVISION
**LANCASTER, PENNA., U. S. A.**

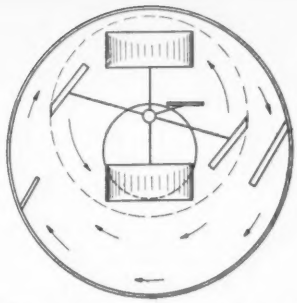
# Lancaster

The "Lancaster" Mixing System, with its scientific control of the batch during the entire mixing operation, provides a new and dependable efficiency in the art of Industrial Mixing.

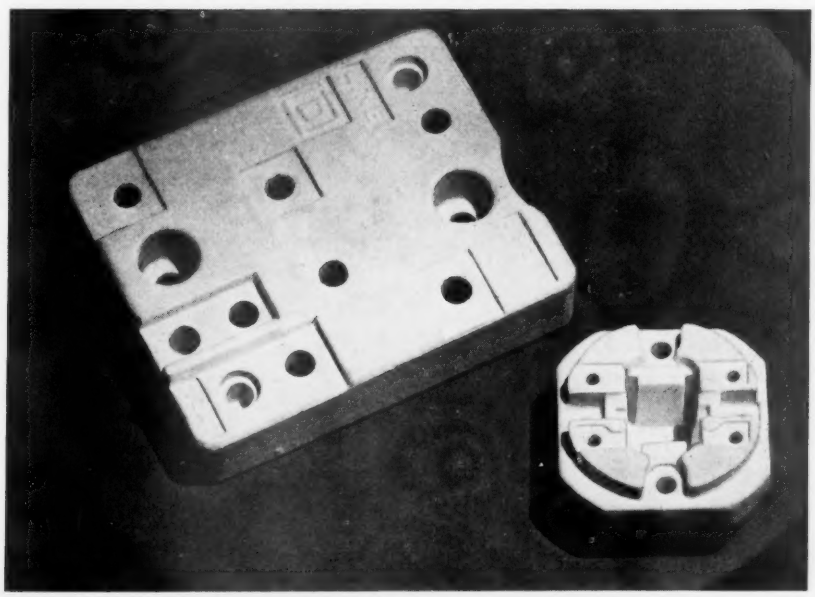
All batch materials are intensively processed many times during the mixing cycle, enabling development of simple or difficult formulas to the highest degree. Yet where it is important, particle sizes are not altered or destroyed while being uniformly distributed and coated with bond.

The mixing pan rotates in clockwise direction carrying materials into a mixing area established off-center of the pan by counter-clockwise rotating plows and mullers. The whirlpool action thus created serves to distribute solids and liquid additions with perfect uniformity regardless of size, shape or specific-gravity.

Any processing within the range of Dry, Damp, Soft-kneadable, Stiff-kneadable or Slurry consistency merits the advantage of Scientific "Lancaster" Mixing. Write, wire or phone for details on an application to your requirements.



*Illustrating the path which each grain of the batch must cover. A result is obtained that is free from mistakes or indifferent mix*



*Soft Plastic or Stiff Plastic Ceramic Bodies are developed to their highest possible degree*

**LANCASTER IRON WORKS, INC.**
BRICK MACHINERY DIVISION
**LANCASTER, PENNA., U. S. A.**

*Tunnel, Truck and Humidity Dryers*
*for—*
Dry Pressed Electrical Porcelain
High Voltage Electrical Porcelain
Sanitary Porcelain
Floor Wall Tile
Abrasive Wheels
Glass Pots and Blocks
Refractory Bricks and Shapes
Also Stove Rooms and Mangles for General Dinnerware

**PROCTOR & SCHWARTZ, INC.**
The Largest Builders of Drying Machinery for Industry
Seventh Street & Tabor Road, Philadelphia, Pa.

**PROVEN PERFORMANCE**

**THE PORCELAIN ENAMEL & MFG. CO.**
*Porcelain Enamels, Frits, Coloring Oxides and Supplies*
PEMCO AND EASTERN AVES., BALTIMORE, MD.

**CLAYS**
**English China and Ball**
**TALCS**
*for*
HEATING ELEMENTS
CERAMIC BODIES
SAGGER USES

*Ceramic Specialties Include*
Whiting : Paris White : Magnesite
Cornwall Stone : Barium Carbonate
Zinc Oxide : Enameling Clays : Etc.

HAMMILL & GILLESPIE, INC.
*Importers since 1848*
225 Broadway New York

**RESEARCH WORKERS**

We offer every cooperation, assistance and counsel in developing new ideas applying to ceramic products of all kinds. . . . Write or call at our office, where complete laboratory and technical facilities are available.

Distributors for the following Foote Minerals—Amblygonite, Antimony Sulphide, Barium Carbonate, Beryl, Chromite, Black Iron Oxide, Red Iron Oxide, Kaltan, Lithium Salts, Manganese Dioxide, Rutile, Fused Silica, Spodumene, Thorium Oxide, Zirconium Oxide.

Edgar Clays—Florida and Georgia—for Every Pottery Service. Wyodak Bentonite, Licensed under Kraus patents.

EDGAR PLASTIC KAOLIN CO.
Metuchen, N. J.
*Over Half a Century of Satisfactory Service*

**Wanted to Buy**

September 1925
Journal, Part II

American Ceramic Society
2525 N. High St. Columbus, Ohio

**FOR CLAY FILTRATION**
**use**
**METAKLOTH**
(green)
**Silvakloth**
(black)

The oldest and best cupra-ammonium finish for

**POTTERY FILTER FABRICS.**

This finish gives the fabric a smooth, lustrous, metallic surface—no fibres to catch and break the clay cake as it comes away in one perfect piece—filters better and faster than untreated cloths—requires fewer washings and is easier to keep clean—more continuous operation of your press—lower labor costs and a larger and better product with the same machinery.

The fabric is mildew proofed—has an increased tensile strength—has a longer useful life.

This means larger profits for you.

Consult your bag manufacturer or write to,

**Metakloth Company, Lodi, N. J.**

## A secret of superior enamelware and glassware that was literally LOCKED IN ICE

KRYOLITH, the fluoride flux and opacifier that has done so much to make possible today's improved enamels and glass, was first found as a mineral beneath the snow and ice of Greenland.

It has been less than 100 years since this material has been commercially available. Yet much of the modern development of the ceramic industry has been based on the unusual properties of Kryolith. Its strong fluxing action of long duration which increases with the furnace heat, and its low melting temperature have helped to bring improved qualities and greater durability to modern enamel products. In addition, the opacification it produces has helped in many instances to lower costs.

In glassware, Kryolith has contributed to the development of some of the most beautiful new shades and tints which have increased the popularity of glass. These are a few of the reasons why it pays to be sure the frit you buy is made with the genuine natural material—Kryolith.

Pennsylvania Salt Manufacturing Company, Widener Building, Philadelphia, Pa.—New York • Chicago • St. Louis • Pittsburgh • Tacoma • Wyandotte.

**Kryolith**

THE NATURAL GREENLAND CRYOLITE

PENNSYLVANIA SALT MANUFACTURING COMPANY

*Chemicals*

## ALPHABETICAL LIST OF ADVERTISERS


| | Page |
|---|---|
| American Potash & Chemical Corporation | 8 |
| American Rolling Mill Co. | 7 |
| Bethlehem Steel Company | 21 |
| Buyers' Guide | 12, 18, 20, 22 |
| Carborundum Co. | 15 |
| Ceramic Color & Chemical Mfg. Company | 21 |
| Corhart Refractories Company | 10 |
| Denver Fire Clay Co. | 21 |
| DeVilbiss Co. | 9 |
| Drakenfeld, B. F., & Co. | Inside Front Cover |
| Du Pont de Nemours, E. I., & Co., Inc. | 23 |
| Edgar Plastic Kaolin Co. | 4 |
| Edward Orton, Jr., Ceramic Foundation | 14 |
| Frazier-Simplex, Inc. | 11 |
| Government Ceramic Industries | 13 |
| Hammill & Gillespie, Inc. | 4 |
| Hartford-Empire Company | 8 |
| Hommel, O., Company | 14 |
| Industrial Ceramic Products, Inc. | 19 |
| International Pulp Co. | 19 |
| Lancaster Iron Works, Inc. | 2–3 |
| Louthan Mfg. Co. | 19 |
| Maxson, Elwyn L. | 17 |
| McDanel Refractory Porcelain Company | 8 |
| Metakloth Co. | 4 |
| Metal & Thermit Corporation | Outside Back Cover |
| Montgomery Porcelain Products Co. | 6 |
| National Engineering Co. | 25 |
| Norton Co. | 26 |
| Orton, Edward, Jr., Ceramic Foundation | 14 |
| Pacific Coast Borax Company | 25 |
| Paper Makers Importing Company | 17 |
| Pennsylvania Salt Mfg. Co. | 5 |
| Porcelain Enamel & Mfg. Company | 4 |
| Potters Supply Company | 13 |
| Proctor & Schwartz, Inc. | 4 |
| Professional Directory | 19 |
| Society of Glass Tech | 14 |
| Solvay Sales Corporation | 8 |
| Spinks, H. C., Clay Company | Inside Back Cover |
| Swindell-Dressler Corp. | 19 |
| Thomas Alabama Kaolin Co. | 19 |
| United Clay Mines Corp. | 8 |
| Vitro Mfg. Company | 6 |
| Wilson, H. W., Company | 25 |



**MONTGOMERY PORCELAIN PRODUCTS COMPANY**

SPECIALIZING IN

**Primary Protection Tubes for all makes of Pyrometers**

**MONTGOMERY**

(M) TRADE MARK (M) TRADE MARK

**PYROMETER TUBES**

★ CORUNDUM

★ REFRACTORY PORCELAIN

MONTGOMERY PORCELAIN PRODUCTS CO.
FRANKLIN OHIO

**QUALITY COLORS for QUALITY WARE**

Whether your requirements are large or small, we take the same painstaking care to serve you promptly and efficiently. Write us on any problem involving ceramic color.

★ Overglaze Colors ★ Vitreous Colors ★

★ Acid Resistant Colors ★ Oxide Colors ★

★

COLORS — CHEMICALS — SPECIALTIES

**THE VITRO MANUFACTURING CO.**
CORLISS STATION PITTSBURGH, PA.
16 California St., San Francisco, Calif.

# The case of the mysterious hairlining!

## X Solved by the ARMCO Enameling Consultant

HAIRLINING may be all right in a mattress, but it has no place on the edge of a newly enameled stove panel. So thought the enameling foreman of a large stove company who called in an ARMCO Enameling Consultant to investigate.

A check of the enameling process found everything apparently in order. Several procedures were tried, such as sponging panels with cold water before firing. Still hairlined edges.

"Let's try raising the temperature 100 degrees," the ARMCO Consultant suggested. The result was perfect firing, much to everybody's surprise.

But ARMCO's representative knew something was still wrong. 24-gage panels do *not* fire perfectly at 1700 degrees. It all looked pretty mysterious till the temperature control was checked and found to be 100 degrees high. That meant the panels originally were being underfired and hairlining resulted.

This is another example of the service ARMCO renders the enameling industry. There'll be times when you, too, can benefit from this long, practical experience—and it costs you nothing. Just tell us your problem. The American Rolling Mill Co., 2300 Curtis Street, Middletown, Ohio.

**ARMCO ENAMELING IRON**

*THE WORLD'S STANDARD*

**McDANEL REFRACTORY PORCELAIN COMPANY**

*Manufacturers of*

PYROMETER TUBES AND INSULATORS
COMBUSTION TUBES AND BOATS
GAS ANALYSIS TUBES

LABORATORY GRINDING JARS
PORCELAIN MILL LININGS
PORCELAIN GRINDING BALLS

BEAVER FALLS PENNSYLVANIA

THREE ELEPHANT

REG. U.S. PAT. OFF. REG. U.S. PAT. OFF.

AND BORIC ACID

GUARANTEED OVER 99.5% PURE

AMERICAN POTASH & CHEMICAL CORPORATION

70 Pine Street, New York

CLAYS

AIR-FLOATED SHREDDED GROUND

FOR EVERY CERAMIC NEED

UNITED CLAY MINES

CORPORATION

TRENTON . . . . NEW JERSEY

HARTFORD-EMPIRE COMPANY

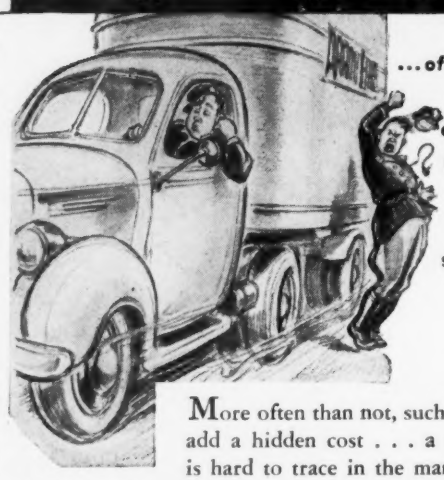
HARTFORD, CONN.

Engineers and Licensors

FEEDERS FORMING MACHINES CONVEYORS

STACKERS LEHRS

HIT OR MISS METHODS



...of ordering your alkalies do not result in savings

More often than not, such methods add a hidden cost . . . a cost that is hard to trace in the manufacture of your products. Write for the Solvay Products Book today for information on *ALL* Solvay Alkalies!

SOLVAY SALES CORPORATION

*Alkalies and Chemical Products Manufactured by The Solvay Process Company*

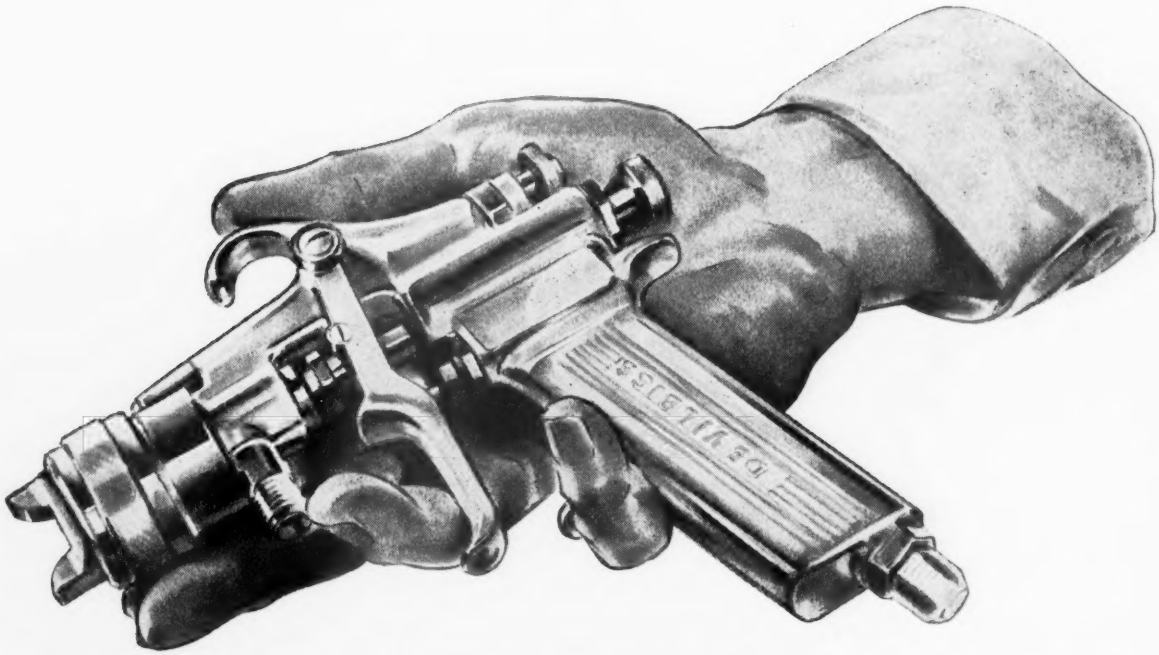
40 RECTOR STREET NEW YORK, N. Y.

*BRANCH SALES OFFICES:*

Boston Charlotte Chicago Cincinnati Cleveland Detroit New Orleans New York Philadelphia Pittsburgh St. Louis Syracuse

SOLVAY ALKALIES

# THE HELPING HAND



## DeVilbiss Serves American Industry

● DeVilbiss has made possible new standards of finishing for American industry. To the casual observer this alone seems important enough, in an age when color and decoration affect the sale of so many products, from saxophones to gangplows, from toys to motor cars, from hairpins to refrigerators.

But the total contribution made by DeVilbiss is much more far-reaching.

DeVilbiss Spray Systems have speeded up finishing processes to the pace of modern manufacturing operations, and eliminated what was once considered the "bottle-neck" of production. They have transformed the finishing department into a model of orderliness, sanitation and safety. They have increased the productivity and earning power of labor, and have bettered working conditions. They have brought about valuable economies in time and cost of materials, to be passed on in lower selling prices, for the development of wider markets.

DeVilbiss is proud of its position as a "helping hand" to American industry. Wherever any coating or finishing process is employed, DeVilbiss Spray Systems offer willing assistance to improve quality of products, efficiency of operations, and volume of business.

THE DEVILBISS COMPANY • TOLEDO, OHIO

Canadian Plant: WINDSOR, ONTARIO

DEVILBISS SPRAY SYSTEMS

# WHERE SHOULD CORHART* ELECTROCAST BE USED?

THE photographic construction detail above shows the extent of Corhart* Standard Electrocast used in the side and breast-wall locations recommended for a typical modern glass furnace.

The use of Corhart* Standard Electrocast in all these locations has literally grown by the necessity and the experience of furnace operators. In practically all cases, Corhart* Standard Electrocast has won its acceptance through hard trial competition with all other materials available for the purpose.

Extending over five continents and a period of more than ten years, the increasing use of Corhart* Standard Electrocast is the best proof possible that Standard Electrocast offers greater economy than any other refractory material commercially available. The use of such a material for mere "spot" fortification is to deny the accumulated experience of almost every important glass manufacturer in the world.

Corhart Refractories Co., Incorporated, 16th & Lee Streets, Louisville, Kentucky. . . . . *In Europe:* L'Electro Refractaire, Paris. *In Japan:* Asahi Glass Co., Tokio.

* Not a product, but a trade-mark.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

# THE BULLETIN

## OF THE AMERICAN CERAMIC SOCIETY

**A Monthly Publication Devoted to Proceedings of The Society and Promotion of Cooperative Research of Technical, Scientific, and Art Questions**

**Volume 19** **AUGUST, 1940** **Number 8**


## PAPERS AND DISCUSSIONS

# SYMPOSIUM ON "SUBSTITUTION OF AMERICAN FOR IMPORTED CLAYS IN WHITEWARE BODIES"*


W. R. MALKIN AND J. R. BEAM, *Presiding Chairmen*


## INTRODUCTION TO SYMPOSIUM†


BY ARTHUR S. WATTS


### (1) History of Use of Kaolins

Primary kaolin was first used in ceramics in China before 1500 B.C.; it was used next probably in Italy about A.D. 1550; then in Saxony, Germany, about 1709 and in France, about 1720; American kaolin from North Carolina was imported into England about 1740; and finally, kaolin or china clay in Cornwall, England.

There is less definite information regarding secondary kaolins, but the deposits in Karolinenthal, Bohemia, were known soon after 1800; various other white clays were known in Germany before 1840; and the secondary kaolins of South Carolina and Georgia were known before the Civil War.

Ball clays were known and used in England before 1800, and the fat or plastic clays of Saxony, Germany, were used at Meissen in about 1800.

The American kaolins of Delaware and Pennsylvania were used before 1850, and probably as early as 1770, when porcelain was first made in Philadelphia. The North Carolina kaolins were not important as an industrial product until after 1888, and the secondary kaolins of South Carolina and Georgia did not enter the ceramic market in quantity until after 1890.

The ball clays of New Jersey were used in pottery bodies before 1850, and the Kentucky-Tennessee ball clays were being mined and marketed about 1880. Ball clay was also mined in Missouri before 1890.

### (2) Use of American Kaolins

With abundant American primary and secondary kaolins and ball clays on the market and available at prices definitely lower than foreign clays, why were they not used extensively until after 1900?

There are at least three answers to this question. (1) The whiteware industry was developed in this country by Englishmen, and most of the master potters were trained in England to use English clays; the molding characteristics of the bodies in which any other clays than English ball and china clays were used were so different that the workmen immediately condemned them. (2) Shipments of American clays were not uniform in character or quality; succeeding shipments were different from the original shipment, and the user was unable to maintain standards. (3) The shrinkage and fired characteristics of the body varied, and because of his meager knowledge the American potter was unable to adjust the body to produce a satisfactory product.

Through the research and cooperation of government bureaus, clay supply companies, and many trained ceramic engineers, the knowledge necessary to replace imported clays by American clays is now available. American clays are produced in quality and in uniformity fully equal, if not superior, to imported clays.

All of those, however, who have had personal experience with clays know that they differ in characteristics that are not included in the list of measurable properties. One of these differences undoubtedly is connected with that indefinite property known as "plasticity." Attempts to measure this property by viscosity, pH, and bonding strength have not been successful. Grain-size measurements indicate promise, but they have not yet been made commercially practicable.

### (3) Characteristics of American Kaolins

In my studies of clays over many years, I have recognized two characteristics connected with all plastic clays. For lack of better terms, I have called these qualities (*a*) "stickiness" and (*b*) "greasiness."

Stickiness is more apparent in the American ball clays and secondary white clays than in the English


* Presented at the Forty-Second Annual Meeting, American Ceramic Society, Toronto, Canada, April 11, 1940 (Materials and Equipment and White Wares Divisions Joint Session).

† Received May 18, 1940.

ball and china clays. Florida kaolin is stickier than any European kaolin, but the modern refinement of North Carolina kaolins has yielded a product practically equivalent to the kaolins of Bohemia.

Greasiness is more apparent in the English ball and china clays than in either the American or the continental European clays of the same classes.

This property of greasiness is not the result of a decreased stickiness, because this characteristic cannot be obtained by decreasing the amount of a sticky clay even when the nonplastic material is simultaneously changed to the finest air-floated grain size.

A study of clay plasticity as evidenced by these two characteristics would help a great deal to solve the problem of the substitution of one clay for another, both in cast- and plastic-molded bodies.

### (4) European vs. American Whiteware Bodies

The substitution of American for imported clays in whiteware bodies is thus confined (as far as we are concerned) to the relative behavior and properties in American whiteware bodies under American manufacturing conditions. Every American clay producer has invested much time and money in solving these problems for his patrons, and with their aid foreign clay supplies are rapidly being eliminated. The story of how this has been done in individual cases would be of enormous value to the ceramic industry as a whole and should be a source of pride to every contributor to this Symposium.

Department of Ceramic Engineering
Ohio State University
Columbus, Ohio

## PROPERTIES OF AMERICAN KAOLINS AND ENGLISH CHINA CLAYS

By T. A. Klinefelter

You may be somewhat disappointed in this talk because I am going to make a plea rather than to present a lot of data and curves.

Fifteen years ago (about 1925) and chiefly as a result of World War conditions, rather intensive studies were started on the substitution of American for English china clays. The English china clays were used extensively at that time by the producers of semivitreous dinnerware; very few, however, are being used now. This change took place as a result of research studies conducted by government agencies, universities, and manufacturers.

At the present time, a large amount of data has been accumulated; some of it is good, but much of it perhaps is not so useful. General conclusions may be drawn, but some of the data needs to be discounted, first, because many of the samples used may not have been truly representative, and, second, because the majority of the body batches were calculated on the old clay-flint-feldspar basis.

The importance of good sampling cannot be overestimated. This is especially true in view of the fact that a 200-pound sample may last an academic investigator several years; in the meantime, thousands of tons of the clay sampled are being used yearly. It is hardly fair, not to say unscientific, to announce that a certain clay will be suitable for a product when the investigator bases his conclusions on a few pounds sent to him from an odd carload lot that some producer or consumer has gathered up hastily.

To insure adequate sampling, the investigator should select his own samples from a large shipment; actually, this is rarely done. For this reason alone, published reports should be checked carefully, and conclusions that are based on small differences should be ignored.

The method of figuring body batches has invalidated a certain amount of past research along these lines. This statement itself might be called one of the main general conclusions of the work on clay substitutions. As we have gained information from the data being developed, it has become increasingly apparent that either a different basis must be used for body calculations or that a more accurate method of calculation must be developed. This is the plea I referred to at the beginning of this discussion.

Feldspar substitutions, not so many years ago, were made in the same loose pound-for-pound substitution as clay substitutions are now being made. Through the work of various investigators, however, particularly that of Professor Watts and of the Feldspar Committee of The Society, the point was emphasized that we must know feldspar both chemically and mineralogically in order to make substitutions with any degree of accuracy. These tests have now become rather common practice.

Curiously, however, now that new fluxes, such as nepheline syenite, are coming to our attention, substitutions are being urged on the basis of "greater vitrification," and this conclusion is based largely on the old pound-for-pound substitution. This method, of course, has its value in getting a rough idea of the use of these materials, but if the use of other fluxes is considered seriously and if we wish to gain the advantage of a lower cost, the right sort of calculations will save time and money.

We should know both the chemical and mineralogical content of the clays. This suggestion is not new because it was formerly customary to figure body batches by empirical formulas, much as glaze batches were calculated. The results were not particularly adequate then and that kind of calculation has been discontinued. The lack of uniform shipments, perhaps, as well as a lack of consideration of other factors affected the use of this method.

The producers of American clays have greatly improved both the quality and uniformity of their clays, and many of the troubles appearing some years ago when substitutions were tried would not show up at all now because uniformity of materials has become a standard practice. Kiln control has also improved to such an extent that the problem of substitution has become more simple.

One outstanding difference between English and American china clays illustrates the points under consideration. Everything else being equal, an English china clay will vitrify about one cone lower than the nearest equivalent of American clay. In some bodies, this might cause serious results, and the usual pound-for-pound substitution therefore would not be suitable. English clays, from a mineralogical analysis, contain a much higher percentage of finely divided mica, which is a flux at porcelain heats. Although other factors are present, the mica content would be sufficient to cause earlier vitrification. Part of this vitrification effect may be related to the delayed release of water vapor given off by the mica. Whatever the cause, allowance should be made in the case of substitutions for the fluxing effect of the mica.

When calculations are made on a mineral basis, whether for clay or feldspar or for one of the newer fluxes, the properties inherent in the mineral form itself must be considered. To refer again to nepheline syenite as an illustration, its fluxing characteristics are those of a soda feldspar; on firing ware made with it, however, there is less warpage rather than an increased tendency to it as would occur if a pure soda feldspar were used. The properties of a clay in the plastic and dry state, furthermore, present factors for body mixing that are fully as important as the fluxing tendencies or other fired properties.

The whole problem is complex, and the more involved it becomes, the more necessity there is for careful and accurate body batch calculations.

NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C.

## Discussion of Klinefelter Paper

**Hewitt Wilson**

May I ask about the relation between the delayed action caused by water release from English china clays containing mica impurities and their warpage?

**T. A. Klinefelter**

There is water in the mica which comes out later than from other ordinary minerals in the clay. Badger[1] showed that water vapor lowers the vitrification of porcelain bodies and feldspars. A possibility therefore exists that the delayed water of the mica might affect the vitrification.[2]

**Hewitt Wilson**

Does mica-water release occur before the sealing in of the surface at the beginning of vitrification?

**T. A. Klinefelter**

Yes, below that of feldspar.

**Hewitt Wilson**

I do not understand how the delay in water removal, which precedes vitrification, alone can affect the warpage occurring after vitrification has started. If mica yields important valuable properties, would there be a sale for finely ground muscovite? Sieve and sedimentation tests have indicated that mica occurs in some of the prepared North Carolina kaolins, and because mica is one of the chief impurities in the original kaolin rock, the finest mica particles which correspond in size to the coarser kaolin particles undoubtedly will be found in most of them.[3]

Several producers in North Carolina are developing flotation or grinding methods to remove mica from clay and from other sources. A ceramic grade of mica may possibly be developed in the near future.

**T. A. Klinefelter**

Work at the Columbus Station showed that mica could be used as a flux to replace feldspar. It was difficult at that time to obtain it in a fine enough grain and nothing further was done.

**L. E. Thiess**

Has the high alumina content of the syenite any effect in preventing warpage?

**T. A. Klinefelter**

Yes, but the essential characteristic of syenite in producing better vitrification is the effect of soda feldspar as contrasted with that of potash feldspar.

**F. P. Hall**

The mica in the English china clays is very fine. There is plenty of mica in some of our domestic kaolins, but most of it is removed in the purification of the clays. Most American micas have a poor color when they are fired (I have made about two dozen tests). Any degree of fineness may be obtained; in fact, we can micronize mica to 2000-mesh. Its fluxing characteristics, I believe, are due to the concentration of alkalis. Mica is a very dilute flux. If its chemical composition is considered, we shall find that the alkali content is very low compared to that of feldspar.

**T. A. Klinefelter**

I did not intend to give the idea that mica is a whole lot better than other fluxes. It is known to be a flux, and this probably accounts for the earlier vitrification of the English clays.

**Louis Navias**

How do you intend to govern the mineral constituents in these clays? The idea of analyzing the clays for mineral constituents is not very fashionable in this country.

**T. A. Klinefelter**

That point is true because analyses may be worked out in two or three different ways, depending on the mineralogical assumptions. The best we can do is to use a combination of chemical and petrographic analyses. If the petrographic microscope shows a predominance of one mineral, the calculations are made accordingly. This method probably is not wholly adequate, but it is better than guessing at the clay and feldspar contents.

**J. R. Beam**

Mr. Klinefelter has brought up a new thought here that should be extended. Is this a purely chemical basis? If we were to make this assumption, we should draw the distinction between those materials that go into solution or are active in a particular heat treatment and those that

[1] A. E. Badger, "Effect of Various Gaseous Atmospheres on Vitrification of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **16** [2] 107–17 (1933).

[2] W. W. Meyer and T. A. Klinefelter, "Substitution of Domestic for Imported Clays in Whiteware Bodies," *Jour. Research Nat. Bur. Stand.*, **19** [1] 65–79 (1937); R.P. 1011; *Ceram. Abs.*, **16** [9] 280 (1937).

[3] See note from "Final Progress Report on Plastic Primary North Carolina kaolins, etc.," *Jour. Amer. Ceram. Soc.*, **22** [7] 245 (1939).

are inactive. An example may be found in the substitution of flint of two different sizes. It is only natural that flint of a very fine grain size will have a greater reaction in the kiln than a coarse-grained flint. With the same body composition, two different types of porcelain could be made.

It is interesting to learn that Mr. Klinefelter is combining a chemical-petrographic analysis to check bodies.

**T. A. Klinefelter**

I did not mean to give this impression. I have mentioned the properties in the plastic and dry state, in which the degree of fineness and the plasticity naturally must also be considered.

**A. S. Watts**

A few years ago, I investigated the relation between the source of silica and its solubility in potash and soda feldspars. I added small quantities of calcined kaolin; heated the feldspar until distortion occurred; and then used a process of shattering, grinding, and reheating several times until an isotropic glass was obtained. The feldspars apparently took up the free silica much more readily than when it was added as pulverized flint, probably because it existed as embryonic quartz or silica mineral which was liberated when the clay broke down. In adding kaolin alumina was added to the feldspar, which definitely lengthened its deformation range. Some of the tests made with soda and potash feldspars in which a moderate amount of the other was present have given surprising results. There was not the rapid loss of shape that I had expected. I had thought that the soda feldspar at an early stage in its vitrification development would begin to produce distortion, but this did not occur. Hewitt Wilson has produced some white chinaware of a good quality with soda feldspar (we have some of these specimens at Ohio State University). I was surprised to find that soda feldspar was not so bad a material to use as we had been led to believe.

Nepheline syenite seems to have the characteristics of a soda feldspar loaded with alumina and a proportionately lower silica content. We naturally expect its viscosity to increase during the vitrification stage, and this characteristic should not be overlooked in the consideration of any mineral.

Muscovite mica has 1 molecule of alkali or potash, 3 of alumina, and 6 of silica; it has 2 molecules more of alumina than pure potash feldspar. Although its dehydration phenomenon should be considered, the use of mica may probably focus on its higher alumina content.

## Discussion on Norton Studies

**Editor's Note**

The paper, "Study of Fractionated Whiteware Clay (Preliminary Study)," by F. H. Norton, Massachusetts Institute of Technology, is not yet available for publication because the work is still in progress.

**J. R. Beam**

In treating clay with hydrogen peroxide, is there a relation between the plasticity and the amount of oxidation caused by the use of hydrogen peroxide?

**F. H. Norton**

There is a change in the treatment. The oxidation is complete in the first treatment of kaolin with the hydrogen peroxide and the reaction is very slight. With the ball clay, there is a vigorous reaction because of its high content of organic matter. The ball clay, after this treatment, is practically as white as the best kaolins.

**W. H. Earhart**

In the work on electrodialysis, electrodialyzed clay is always used; in practice, however, this is not the clay with which we are working and we have no data on the clay as we use it.

**F. H. Norton**

We start with a clay that we know is clean and with no adsorbed ions, that is, a hydrogen clay. The ions are added in definite amounts and the properties resulting from the adsorbed ions are determined. It is a rather difficult matter to determine the exact amount of adsorbed ions in a raw clay, but we know that they have a profound influence on the physical properties of clay.

I know of two Georgia kaolins, one a high flintlike kaolin and the other a soft kaolin, that seem to be identical except that the amount of adsorbed calcium on the hard kaolin is approximately ten times that on the soft. By cleaning the clay and by adding the ions back in definite amounts, we have a controllable measure with which to work.

**T. A. Klinefelter**

We are working on a half dozen regular American ball clays and two or three English clays. The clays treated with calcium and barium ions do not show much difference from the clay as it is received. The greatest increase in strength occurs with the use of sodium. We tried, without much success, to synthesize ball clay from china clay. The problem now is to measure the plasticity, but a satisfactory method so far has not been found.

**L. E. Thiess**

What do you mean by changing china clay into ball clay?

**T. A. Klinefelter**

We were using organic additions, such as humus. Particle size, of course, affects it, and this cannot be duplicated readily.

## Discussion on Sproat Studies

**Editor's Note**

The paper, "An All-American Sanitary Ware Body," by I. E. Sproat, C. C. Treischel, and E. W. Emrich, R. T. Vanderbilt Company, New York, N. Y., was preprinted and presented, but because the work is still in progress, it will not be published at this time.

**Louis Navias**

The Stormer viscosimeter, as I understand it, is run while the weights drop and the mixture stands a few minutes; then the weights are pulled up, and the process is repeated. We started to use a modification of this viscosimeter, whereby the outer cylinder is rotated continuously and the inner cylinder hangs on a wire or a strip of metal. A continuous test of this kind might produce additional information to the results that you are getting now.

The bodies that were tried in a clay-water mixture showed that, as the cylinder rotated, water accumulated around the cylinder and there was a continuous change in viscosity which, as Treischel indicated, had no meaning in terms of true viscosity.

**C. C. Treischel**

As far as viscosity measurements are concerned from a control standpoint, the Stormer viscosimeter does not seem to be any good. With most clay slips, the viscosity changes on standing, and this is the particular characteristic we want to measure. The Stormer viscosimeter is the best apparatus that we have encountered thus far, but we would like to find something better.

**L. E. Thiess**

What you really want is a test for the thixotropic content of the slips.

**C. C. Treischel**

That is right, except that I do not like the word, "thixotropic." It means "temporary thickening," and we get into a lot of trouble by its use.

**F. P. Hall**

When clay slips are tested on this type of viscosimeter, a "puddling" effect (separation of clay and water) is noted in the region adjacent to the inner cylinder. The use of a paddle in the place of the inner cylinder eliminates this puddling effect.

**C. C. Treischel**

We do not want to measure viscosity. At least we hope that we are not measuring viscosity as it is used for control work. We want to measure the thickening. That is why we stop the equipment and let the slip thicken before another reading is made. The cylinder is rotated for only fifteen seconds during each cycle, which means that this gives the minimum of disturbance to the slip. There is a sufficient length of time, furthermore, to make a fairly accurate reading. We do not want to break up the jelling or thickening effect any more than is necessary.

**W. K. McAfee**

Have you made a comparison of the dry strength in these bodies?

This is an important subject and, incidentally, one that has been overlooked by many clay producers. Lack of green strength is one of the most important handicaps to overcome in the use of domestic ball and china clays. This is true particularly in view of the fact that our domestic clays are somewhat more refractory than the English clays and because it is necessary to use more fluxes (usually feldspar), which results in a smaller clay content.

**C. C. Treischel**

We have not done this because we received the mold that we had made for test bars only a little more than a week ago. I do not believe, however, that this body is as strong as any of the three commercial bodies, particularly the one with a high ball-clay content. There were a number of points wherein this American body was somewhat inferior to the commercial bodies. The vitrification point was about two cones higher, the strength was not quite up to what it should be, and the casting rate was much faster. It is possible that this may be corrected simply by increasing the content of the ball clay at the expense of the kaolin.

# AMERICAN CERAMIC MATERIALS IN POTTERY*

By Hewitt Wilson and Ernest Wilson†

## I. Introduction

Although an increasing number of new domestic raw materials has been introduced in the ceramic industry, including dumortierite from Nevada and pyrophyllite from North Carolina, the use of American materials instead of those from foreign countries is by no means universal in our pottery manufacture. Domestic materials have replaced those materials whose chief value depends on their chemical composition and where a natural physical property is not important; for example, feldspars have largely replaced Cornish stone, and ground quartz has replaced Dover flint except in a few instances.

But materials are still imported to replace domestic materials in which natural color, plasticity, firing characteristics, or certain working properties (intangibles) are not under accurate control. Among these are certain orange-yellow French ochers and Italian siennas, English china and ball clays, and gray plastic chalk for whiting.

The direct substitution of a pound of one clay for a pound of another has resulted in many failures because the number of physical, chemical, and mineralogical variables is too great. To these three classes of variables, two others should be added, e.g., $x$, which should be introduced into the formula to take care of our general ignorance of the underlying causes of variation in plastics, and $y$, to indicate our inability to control the variables on a commercial scale if $x$ is known.

When a potter has a process running smoothly, including mold sizes, personnel trained to given working properties, drying schedules, glaze fit, and firing schedule and temperatures, he cannot be blamed for refus-

* Received May 29, 1940.

† The authors are, respectively, supervising engineer and potter, U. S. Bureau of Mines, Department of Interior, Electrotechnical Laboratory, Norris, Tenn. These Progress Reports are published by permission of the Director, Bureau of Mines, Department of the Interior (not subject to copyright). This work has been done in cooperation with the Tennessee Valley Authority.

ing to make a change in materials even for an initial price saving which represents but a small fraction of the total cost of his product and which may lead to more serious consequences.

The man in the experimental laboratory may draw his conclusions of a given raw material from a single 25- or 100-pound sample. The potter encounters, through the months and years, nature's variations of the raw material in the ground plus those produced in washing, grinding, or other beneficiation processes. A refiner of clay is selling not only the material that nature gives him but also the skill, technique, control, and accuracy of his staff and equipment.

If the new material can be shown to improve the quality of the product and/or to give a reduction in the initial or manufacturing cost, the cost of the necessary research and the substitution troubles will have a chance to be absorbed in increased sales.

## II. Improvements in Domestic Processing

Americans are trying to offset tradition by ingenious methods of beneficiation. Some of the methods used fall in the following groups:

(1) *Hard, Nonplastic Rocks:* Feldspars, quartz, pyrophyllite, kyanite, mica, etc.; (*a*) chemical control; (*b*) tailor-made compositions of feldspars obtained by accurate blending; (*c*) particle-size control by pneumatic processing; and (*d*) removal of impurities by (i) high-intensity electromagnetic methods, (ii) froth flotation, and (iii) agglomerate tabling.

(2) *Soft Plastics:* Kaolins; (*a*) alkali dispersion for cleaner separation of quartz, mica, etc.; (*b*) modern equipment for dispersion, washing, concentration, drying, and pulverizing; (*c*) particle-size separation below the screen fractions by Lyons (Bird) centrifuge and/or assisted by electrical coagulation and precipitation; and (*d*) chemical bleaching processes.

(3) *Soft Plastics:* Ball clay; (*a*) greater care in planning, prospecting, stripping, cleaning, hand sorting, and physical testing; (*b*) drying, grinding, and air-floating; and (*c*) larger storage sheds leading to better mixing and disintegrator "hogging" for uniformity over longer periods.

*Objections:* No positive control of particle size, pH, fine impurities, or soluble-salt content. A time will come, however, when the American potter will realize that he can afford to pay for the cost of some type of beneficiation.

## III. Electrotechnical Laboratory, U. S. Bureau of Mines, Work in Cooperation with TVA

(1) *All-American, All-Kaolin China Body:* Tests developed by the Tennessee Valley Authority staff and reported last year have been continued.

The results are as follows: (*a*) excellent rapid casting found for thin ware with No. 2 deflocculant; (*b*) jiggering properties with laboratory and factory tests indicate that the plasticity is equal to certain hotel china bodies containing small quantities of ball clay; two thirds the jiggering speed of semivitreous bodies obtained; (*c*) no success in casting large thick sanitary ware owing to lack of toughness and strength in removal from mold and to "sticking up"; casting rate fast; (*d*) firing at laboratory higher than that at factories as all samples were reported underfired in the commercial kilns; and (*e*) ball-clay bodies show more gradual, longer vitrification range, subject to better uniformity control with varying temperatures than the all-kaolin bodies with shorter vitrification ranges.

(2) *Domestic Kaolins, Ball Clays, and Alaskite in Sanitary Casting and Jiggered Plate Bodies:* Tests made for (*a*) $Fe_2O_3$ and $TiO_2$ content; (*b*) $SO_4$, Cl, pH, acidity, and dissolved solids determined by analysis of the clay water; (*c*) standard bar tests with range of flint additions; (*d*) tests on 400-lb. bodies made by blunging, screening, filter pressing, vacuum-auger treatment, and casting-slip preparation with alkali; (i) standard plastic bar tests from vacuum auger; (ii) viscosity-alkali-pH relationships; (iii) degree of dispersion versus rate of casting and cracking; (iv) cup-casting tests; (v) full-sized toilet bowl and fountain casts; (vi) cathetometer-shrinkage measurements during firing; and (vii) variation in shrinkage measurements.

## IV. Preliminary Conclusions

(1) Casting bodies for sanitary ware were made at Norris with all-American materials, including china and ball clays. Such a variety of both china and ball clays occurs that the proper combination of domestic materials may be found for almost every set of conditions.

(2) Direct weight substitutions will not give identical results as all clays tested have peculiar individual characteristics.

(3) North Carolina kaolins correspond the most closely of any tested to English kaolins in physical and chemical properties, but they are finer grained, more plastic, and stronger than English clays.

(4) Because the properties of plastic Florida clays approach those of ball clay, it is possible to get white-firing bodies of considerable plasticity and strength without ball clay.

(5) Ball clays, however, because of the fine particle size of the clay base, the fluxing impurities, and other unknown properties, not only excel in plasticity and workability, but they also produce longer and safer vitrification ranges.

(6) Ball clays could be developed into far more useful raw materials for the ceramic industry if the iron oxide and/or titania were reduced sufficiently to produce white-fired bodies. The increased cost could be partially met by the reduction of tin oxide in glazes and the substitution of ball clay for more expensive kaolins.

(7) High ball-clay bodies were found to be more foolproof and easier to work than the low ball-clay bodies.

(8) In the high ball-clay bodies, kaolin substitution (except for Florida plastics) was found to cause less change than ball-clay substitution because plasticity and bonding strength are mainly dependent on ball clay, which likewise stabilizes the vitrification range.

(9) North Carolina alaskite represents a satisfactory and enormous potential source of white-firing,

mixed potash and soda feldspar (plus flint) for many future generations of ceramists.

### V. Future Work

(1) Iron oxide, carbon, and titania removal from ball clays.

(2) Titanium-dioxide removal from Georgia and Alabama kaolins.

(3) Importance of soluble salts, particularly $SO_4$ in clays for casting slips.

(4) Reduction in particle size of weakly plastic kaolins.

(5) Synthetic blending of clays for particle sizing or physical property control.

(6) Plasticity control with new plasticizers.

(7) Flux control with finer alkali and other mineral fluxes.

### Discussion of Wilson Paper

**J. R. Beam**

In reference to the foregoing remarks on soluble salts, the general plant difficulties and the ordinary casting defects, which vary with the soluble-salt content of the raw materials, seem to correlate definitely.

During the last few years, we have analyzed the filtrate from each raw material going into the body and have used distilled water in making up the slip. A study of these analyses indicates that the soluble-salt analysis is more valuable to the ceramist than ordinary routine physical tests, such as shrinkage, water of plasticity, or modulus of rupture.

Soluble-salt contents change with mining operations, types of storage, weathering and oxidation of clay, and several other factors, which to a certain extent are within the control of the clay producer.

When the role of soluble salts is considered in relation to flocculation and deflocculation reactions, there is a definite reason for some of the mysterious changes in a casting slip. The chloride content of the filtrate from one particular shipment of imported clay, for example, increased many times over normal shipments. An investigation of the cause indicated that sea water had contaminated the clay during shipment.

Another soluble-salt variation is apparent in pyrite, a common mineral in many clays, oxidizing into soluble sulfates. This change introduces an ion that is potent and produces serious changes in a casting slip.

We have been unable to predict the properties of a clay from a soluble-salt analysis, but we can tell to a large extent whether we want to use the clay.

## AN ALL-AMERICAN HOTEL CHINA BODY*

By G. A. Loomis and W. H. Earhart

Abstract

Body compositions and comparative test data are presented to show the possibility of developing a hotel china body, made with American kaolins and ball clays to replace English clays, with properties equal or superior to the English clay body that it is desired to duplicate.

### I. Introduction

It has been generally believed that American kaolins could not be used successfully to replace English china clays in hotel china bodies. Statements have been made that the use of English china clays results in bodies with a higher shrinkage and better vitrification and translucency than domestic kaolins that have been used to replace English china clays in such bodies.

An investigation of the use of North Carolina kaolin in hotel china bodies was made by the junior author. The compositions and test data on some of the bodies included in that investigation will be given to show the possibility of producing an all-American hotel china body which has properties equal or superior to one that contains English clays.

### II. Body Compositions and Test Procedure

Fourof the body compositions used are given in Table I. Bodies A and B, containing VC-1 English china clay, were alike except for the ball-clay content; the English ball clay used in body A was replaced by Kentucky Old Mine No. 4 in body B. In body C, the English china clay was replaced by additional Kamec N. C. kaolin and 5% of No Karb Georgia kaolin. In body D, the feldspar was replaced by a reduced amount of nepheline syenite and the North Carolina kaolin content was increased to 35%.

Table I
Composition of Bodies

| Material | Body No. (%) A | B | C | D |
|---|---|---|---|---|
| VC-1 English china clay | 15 | 15 | | |
| EPK Fla. kaolin | 7 | 7 | 7 | 5 |
| No. 25 English blue ball clay | 8 | | | |
| Kamec N. C. kaolin | 15 | 15 | 25 | 35 |
| No Karb Ga. kaolin | | | 5 | |
| Ky. Old Mine No. 4 ball clay | | 8 | 8 | 8 |
| Flint | 35 | 35 | 35 | 35 |
| N. H. feldspar | 18 | 18 | 18 | |
| Conn. whiting | 2 | 2 | 2 | 2 |
| Lakefield nepheline syenite | | | | 15 |

In the test procedure, 5000 grams of each body were prepared by blunging, dewatering to a plastic condition in plaster bowls, and hand-wedging. From these bodies, 1- by 1- by 7-inch bars, 1- by 1- by 2-inch briquettes, and small wedges for the determination of translucency were made by hand-pressing in brass molds.

* Received April 11, 1940.

These test pieces were fired in a laboratory gas-fired kiln to cone 10 in thirty-six hours and in another kiln fired to cone 11 in thirty-eight hours.

The determinations were made on water of plasticity, total volume and linear drying shrinkage, absorption, apparent porosity in the dry and fired state, dry and fired transverse strength, and translucency. The amount of shrinkage was determined on the plastic-state basis, but in all other tests, except for that on translucency, the standard tests of The American Ceramic Society[1] were used. Translucency was determined by measuring the thickness of the wedges at the place where transmitted light could just be detected when the wedge was passed over a narrow slot in a box containing a 60-watt frosted lamp bulb, the test being made in a darkened room.

## III. Discussion of Results

The drying properties of the bodies are given in Table II. Body C was molded with a lower water content than bodies A, B, and D, which caused it to have a lower volume drying shrinkage. Taking the difference in water content into account, bodies A, C, and D had practically the same amount of drying shrinkage. Body B had a lower drying shrinkage than body A, attributable to the Kentucky ball clay used in place of the English ball clay in body A.

TABLE II
PROPERTIES OF DRY BODIES

| | Body No. | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Water of plasticity (%) | 22.1 | 22.6 | 20.5 | 21.8 |
| Volume shrinkage (%) | 16.5 | 15.9 | 14.7 | 16.2 |
| Linear shrinkage (%) | 5.0 | 4.1 | 4.6 | 5.2 |
| Apparent porosity (%) | 31.2 | 31.1 | 29.9 | 30.6 |
| Modulus of rupture (lb./sq. in.) | 230 | 152 | 310 | 307 |

Considering the dry transverse-strength values, body B had a lower strength than body A owing to the use of Kentucky ball clay. The two all-American clay bodies, C and D, however, had a considerably higher dry strength than the bodies A and B which contained English china clay.

Table III shows the properties of the fired bodies. Considering the total shrinkage, the volume determinations should be compared rather than the linear values because linear-shrinkage determinations, which are affected by warpage of the specimen, are inherently less precise than volume-shrinkage measurements.

The total volume shrinkage of bodies A and B, containing VC-1 English china clay, was higher than that of bodies C and D at cones 10 and 11; whereas body B, containing Kentucky Old Mine No. 4 ball clay, had a higher total shrinkage than body A, which contained English ball clay.

The total volume shrinkage of body C would have been about 1.5% higher had it been molded with the same water content as body A (as mentioned in connection with its volume drying shrinkage). The total volume shrinkage at cone 11 then apparently would have been the same as body A.

[1] *Jour. Amer. Ceram. Soc.*, **11** [6] (1928).

The shrinkage data for these bodies indicate that, when an English china clay having as high a shrinkage as VC-1 is replaced with Kamec N. C. kaolin, it might be necessary to replace the ball clay with one having a higher shrinkage to maintain the shrinkage of the original body.

As to vitrification, the absorption and porosity data show that the bodies containing English china clay were definitely more vitreous at cone 10 than the two containing only domestic clays. At cone 11, however, the degree of vitrification of all four bodies was practically the same.

It is evident that Kamec N. C. kaolin and No Karb Georgia kaolin require a higher percentage of fluxes or a more active flux than VC-1 English china clay to produce the same degree of vitrification in a hotel china body. In this connection, 15% of nepheline syenite in body D produced nearly the same degree of vitrification as 18% of N. H. feldspar in body C, even though body D contained more North Carolina kaolin than body C.

Considering the fired transverse strengths, body A had a higher value at cones 10 and 11 than body B, attributable to the higher strength of No. 25 English blue ball clay compared with that of Kentucky Old Mine No. 4. Bodies A and B had higher strengths than bodies C and D when fired to cone 10; at cone 11, however, body C had the highest strength of all four bodies. The relatively low strength of body D doubtless is due to the fact that it was not quite so vitreous as the other three bodies.

It is evident from these data that the all-American clay body C developed fully as good translucency at cones 10 and 11 as bodies A and B with English china clay; body D was not quite so translucent as the other three bodies because it was a little less vitreous.

The fired color of the all-American clay bodies was fully as good a white as it was for those containing English china clay.

TABLE III
PROPERTIES OF FIRED BODIES

| | | Body No. | | | |
|---|---|---|---|---|---|
| | Cone | A | B | C | D |
| Total vol. shrinkage (%) | 10 | 40.0 | 41.3 | 36.6 | 39.0 |
| | 11 | 40.8 | 42.4 | 39.1 | 40.6 |
| Total linear shrinkage (%) | 10 | 9.5 | 13.1 | 9.0 | 9.0 |
| | 11 | 10.1 | 13.4 | 9.0 | 9.0 |
| Absorption (%) | 10 | 0.0 | 0.3 | 1.0 | 1.8 |
| | 11 | 0.1 | 0.1 | 0.1 | 0.1 |
| Apparent porosity (%) | 10 | 0.0 | 0.7 | 2.3 | 3.4 |
| | 11 | 0.3 | 0.2 | 0.2 | 0.3 |
| Transverse strength (lb./sq. in.) | 10 | 7600 | 7300 | 7200 | 6600 |
| | 11 | 9200 | 8500 | 10200 | 7500 |
| Translucency (inch) | 10 | 0.211 | 0.209 | 0.213 | 0.176 |
| | 11 | 0.273 | 0.279 | 0.276 | 0.251 |

## IV. Conclusions

The conclusions which appear to be warranted from this laboratory study of hotel china bodies are as follows:

(1) It is possible to develop an all-American clay

hotel china body to replace one containing English china and ball clays and to duplicate the total shrinkage, absorption, apparent porosity, dry and fired transverse strength, and translucency of the body containing English clays.

(2) The duplication of the total shrinkage of a body in which an English china clay, having as high a shrinkage as VC-1, is to be replaced may require the use of a ball clay with a higher shrinkage than the one used with the English china clay.

(3) The use of Kamec N. C. kaolin, No Karb Georgia kaolin, and other equally refractory domestic clays to replace English china clay may require additional feldspar or the replacement of the feldspar with a more active flux, such as nepheline syenite.

These conclusions are fully substantiated by the fact that a considerable number of producers of hotel chinaware and vitreous dinnerware are now using Kamec North Carolina and other domestic kaolins in regular production to replace part of the English china clay. Several of these producers have stated that they have developed an all-American clay body which duplicates all of the properties of the English china clay body and which may be used in regular production without any difficulty.

Engineering Experiment Station
The Ohio State University
Columbus, Ohio

# SUBSTITUTION OF DOMESTIC CLAYS FOR IMPORTED CLAYS IN ELECTRICAL PORCELAIN BODIES*

By L. E. Thiess

Abstract

Electrical porcelain is manufactured by three methods, (1) dry press, (2) casting, and (3) the plastic or extrusion method. For each method, ceramic bodies containing clays with definite physical properties are required.

## I. Introduction

The substitution of American clays for imported clays in electrical porcelain was first discussed by Fritz[1] in 1925, who reported that Georgia kaolins and Kentucky and Tennessee ball clays may be substituted for English china clays and ball clays.

A considerable amount of research has been carried out in recent years, and great improvements have been made in the production and control of domestic china and ball clays, which have led to an increased elimination of imported clays.

Electrical porcelain is a highly vitrified product. It is manufactured by (1) dry pressing, (2) casting, or (3) the plastic or extrusion methods. For each of these methods, special body compositions are used, each containing clays with definite physical properties. The substitution of domestic for imported clays, therefore, will be discussed in the order named.

## II. Dry Pressing

The substitution of clays for dry pressing does not present great difficulties. It is, of course, necessary to consider the difference in the chemical and physical composition of the imported and domestic clays, such as the amount of fluxes, shrinkage, dry strength, and fired color. The Georgia and Florida clays have higher dry strength and are more plastic than the English china clays. The Georgia and North Carolina clays are more refractory. The fired color of the Georgia and South Carolina clays is not as white as that of fired English china clays. A slight addition of cobalt stain, however, will overcome any slight yellowish cast of the fired, dry-pressed body. In most cases, the substitution of domestic clays for imported clays will result in a substantial saving.

## III. Casting Process

There are several reliable Tennessee and Kentucky ball clays available for use in casting bodies. These clays carry organic electrolytes and their grain size is favorable for casting heavy wall ware. Certain fractionated domestic china clays from Georgia and North

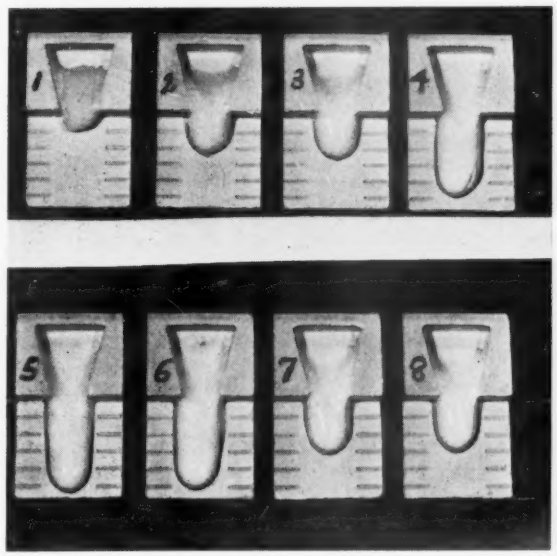



Fig. 1.—Fusion tests of feldspar-talc mixtures. (1) 100% feldspar; (2) 97% feldspar, 3% talc; (3) 95% feldspar, 5% talc; (4) 90% feldspar, 10% talc; (5) 85% feldspar, 15% talc; (6) 80% feldspar, 20% talc; (7) 75% feldspar, 25% talc; and (8) 70% feldspar, 30% talc.

* Received May 18, 1940.

[1] E. H. Fritz, "American Clay sas Compared to English Clays in Whiteware Bodies," *Jour. Amer. Ceram. Soc.*, 8 [4] 253–56 (1925).

Carolina work well in casting bodies. The grain size of china clays in casting bodies is important because of its effect on the rate of casting, water retention, and shrinkage during the casting process. Most of the English china clays have a greater amount of intermediate particles, which are lacking in some of the prepared domestic china clays. A blending of two domestic china clays therefore is advisable. Most of the domestic china clays have a higher dry strength than the English china clays, which results in greater strength and less breakage on the dried, unfired ware.

## IV. Wet Process

In plastic insulator bodies, ball clays are used in amounts of 25 to 30%. The domestic ball clays used in such bodies are supplied from Kentucky and Tennessee mines; English ball clays are used where greater plasticity is desired. These English clays are extremely fine-grained and from 85 to 90% is finer than 1 micron in diameter. (English ball clays are said to vitrify from three to four cones lower than the domestic ball clays.) In substituting domestic ball clays for imported clays, (1) a fine-grained china clay may be used to make up for any deficiency in plasticity and (2) a softer feldspar may be used, the feldspar content may be increased, or a small amount of talc may be added to obtain complete vitrification of the porcelain without raising the kiln temperature.

Small additions of talc to feldspar produce an active flux (see Fig. 1). The New England feldspar contains $SiO_2$ 66.3%, $Al_2O_3$ 18.8%, $K_2O$ 11.4%, and $Na_2O$ 3.1%. The tremolite talc has a composition of $SiO_2$ 57.5%, MgO 30.2%, and CaO 5.2%. Although some of the domestic ball clays fire to a somewhat darker color, this is not so noticeable when they are used in a porcelain body consisting of china clay, feldspar, and flint. Electrical high-tension porcelain is usually glazed brown, green, or black, and therefore the whiteness of the porcelain is not essential.

Some domestic ball clays from the Mississippi Valley have been offered recently, which in plasticity, grain size, and vitrification behavior closely resemble English ball clays. Trial bodies made with these clays, used singly or blended with other domestic ball clays, have shown interesting results and have given porcelain bodies with zero porosity at cone 10 and high electrical and mechanical strengths.

General Electric Company
Schenectady, New York

# SCRATCHING OF GLASS BY METALS*

By L. G. Ghering and J. C. Turnbull

Letter of Transmittal†

This investigation calls attention to that type of scratch on glass which some twenty years ago the present writer called "chatter sleeks." At that time interest centered on the nature of the process of polishing glass by abrasives. More recently the action of metal parts rubbing over clean glass surfaces has come up for consideration and has been found to be important. The scratches there produced are nearly always of the chatter-sleek type.

The behavior of different metals, the effect of detergents, and other practical matters are touched on in the present communication. The paper shows that glass, a fairly hard substance, may be scratched and seriously weakened by metals vastly softer than itself.

— F. W. Preston

## I. Introduction

Glass may be scratched by a variety of minerals, metals, and abrasives, and in general the harder the scratching substance, the more easily is the glass scratched. It is therefore convenient to assign glass a number on Mohs' hardness scale, and the materials which scratch glass evidently ought to have higher hardness numbers on this scale.

Mohs' scale of hardness is an arrangement of minerals, beginning with talc and ending with diamond, such that any mineral may be scratched by all the minerals above it but by none below it. This scale is commonly used for rating the hardness of minerals, as well as that of metals, alloys, and many other commercial materials.

Soda-lime-silica glass will scratch minerals 1 to 4 and therefore should have a hardness rating of 5. Many substances, however, with a rating of less than 5 as well as those greater than 5 will scratch glass. According to Auerbach,[1] any kind of glass will scratch any other kind of glass, and it will be shown that many of

* Received January 5, 1940.

† The "letter of transmittal" over my signature replaces the ordinary abstract. It serves two other purposes. Together with the last paragraph of the paper it indicates that it represents part of a continuing program, other parts of which may be reported by other investigators, but in the same group; and it indicates also a sort of sponsorship or responsibility in case certain commercial interests, outside the glass industry, consider themselves aggrieved.—F. W. Preston, Preston Laboratories, Butler, Pa.

[1] (*a*) F. Auerbach, "Über die Härte- und Elasticitätsverhältnisse des Glasses," *Ann. d. Phys. u. Chem.*, **53**, 1000 (1894).

(*b*) H. Hovestadt, Jena Glass, p. 176. Macmillan Co., London, 1902.

the softer metals, such as aluminum, copper, and soft iron, will scratch ordinary glass. This ambiguity concerning the position of glass on the hardness scale has been overcome by the use of the indentation method of determining hardness developed by Knoop, Peters, and Emerson,[2] which indicates that the hardness of soda-lime-silica glass on Mohs' scale is approximately 5. Evidently the ability of a substance to scratch glass is not uniquely given by its rating on Mohs' scale.

## II. What Is a Scratch?

The apparent discrepancy that substances softer than glass will scratch glass raises the question as to what precisely is meant by a scratch. Bailey[3] describes two kinds of scratches, viz., (1) surface abrasions and (2) scratches produced by crushing the surface.

### (1) Surface Abrasions

Three types of surface abrasions can be produced, depending on the speed of rubbing and the applied pressure, when a sharp corner of one piece of glass is dragged across the smooth surface of another. Under light pressure, the abrasion is confined to the surface layers. Under considerable pressure, a series of embryo conchoidal fractures or cracks, usually at right angles to the path, are formed and the mechanical strength is affected. Under considerable pressure with rapid rubbing, the heat which is formed causes the loose particles of glass to melt together into flakes; a groove unaccompanied by visible cracks is formed, but the mechanical strength is not affected.

### (2) Scratches Produced by Crushing the Surface

This second type of scratch is produced by any hard pointed object. Light pressures are sufficient to form a series of very small conchoidal fractures; the central portion of such a scratch is usually crushed and sometimes pulverized, and many chips of glass fly out. Scratches of this type, formed by specially designed cutting wheels, differ slightly in that the glass ahead and behind the wheel is put into high tension so that a deep vertical crack is formed under the wheel with a minimum of chipping. A diamond cutter crushes the surface, wedges it apart, sometimes with chipping, and forms a vertical crack. All scratches of this type cause a great reduction in mechanical strength.

If scratches of type (2) only are considered in the formation of which a groove is made and material is removed from the glass surface, there is no ambiguity in assigning glass a place on Mohs' scale of hardness. On the other hand, softer materials do not remove material from the glass surface and there is no crushing or abrading of the surface. The scratch produced by softer materials, such as soft metals, is therefore in a different category from those listed by Bailey.

[2] E. Knoop, C. G. Peters, and W. B. Emerson, "Sensitive Pyramidal-Diamond Tool for Indentation Measurements," *Jour. Research Nat. Bur. Stand.*, **23**, [1] 39–62 (1939); R.P. 1220; *Ceram. Abs.*, **18** [11] 307 (1939).

[3] James Bailey, "Scratch-Resisting Power of Glass and Its Measurement," *Jour. Amer. Ceram. Soc.*, **20** [2] 42–52 (1937).

## III. "Chatter-Sleek" Scratch

A study of commercial problems relating to the use of glassware during the past two years has brought this type of scratch to the attention of the writers. Figure 1 shows a scratch made by dragging a blunt copper point over a clean piece of window glass. It is made of a series of percussion crescents, perpendicular to the direction of motion of the point. Bits of metal left on the glass surface are clearly visible, but it will be seen that no material is removed and there is no groove in the glass surface as in the case of the scratches which Bailey describes. Figure 2 shows another section of the same scratch after etching for three minutes in a 2% solution of hydrofluoric acid; this treatment evidently develops the crescents so that they are much more clearly visible.

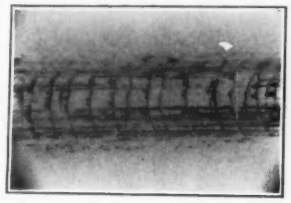


FIG. 1.—A chatter-sleek scratch made by dragging a blunt copper point over a clean piece of window glass. The series of percussion crescents perpendicular to the direction of motion are clearly visible. The dark markings parallel to the direction of motion are bits of metal which adhered firmly to the glass surface; 75×.

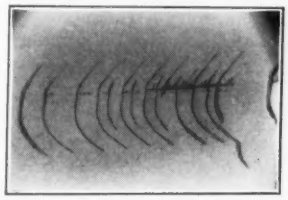


FIG. 2.—A chatter-sleek scratch made by copper, similar to that in Fig. 1 except that the percussion crescents have been developed and the adhering material removed by three minutes of etching with 2% hydrofluoric acid.

Similar chatter sleeks may be formed in the same way with loaded points of a variety of hard and soft metals. Heavily loaded blunt points of hard materials crush the glass in addition to forming chatter sleeks. As the load is increased from light to heavy, there is a transition from the third type of scratch, the chatter sleek, to the second, in which material is removed and crushed.

The tiny percussion-crescent cracks which constitute the chatter sleeks markedly decrease mechanical strength. A decrease in mechanical strength, therefore, does not depend on a groove type of scratch, i.e., the removal of material from the glass surface, but it may be produced by a single tiny percussion crescent or by any other minute break in the surface of the glass.

Because the chatter sleeks formed by metals dragged over glass surfaces have a pronounced effect on the mechanical strength of glass, it was considered important to get comparative data on the loads required by various metals to form the chatter sleeks, as well as any other factors which enter into the formation or prevention of the chatter sleek. These are the objectives of the experimental work which follows.

## IV. Apparatus

The apparatus (Fig. 3) for scratching glass with

metals consists mainly of an arm carrying a pointed tool of the metal under investigation, which rests on a glass surface and is loaded by means of weights placed directly above it. The tool is made from rod $^1/_4$ inch in diameter with one end turned to a hemispherical shape and polished with garnet paper. This blunt point is clamped to the arm at an angle of 45 degrees, and as the point in contact with the glass wears down, a new surface is obtained by turning the rod and reclamping it.

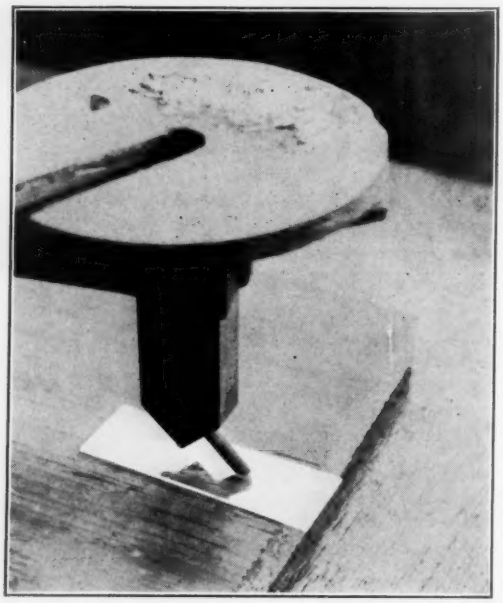


FIG. 3.—The scratching apparatus showing the hemispherical point, the angle of contact of the point with the glass surface, and the method of loading the point. The scratching is accomplished by pulling the glass specimen to the right.

The glass was tested by pulling it at a uniform rate in the direction toward which the rod was inclined. Under these conditions, a series of percussion crescents might be formed, and at the same time a more or less high-pitched noise would be made by the tool and glass. The lowest value of load, or initial load, at which the percussion crescents were formed was found by varying the load in steps and by examining the glass microscopically after etching in hydrofluoric acid.

The removal of foreign material from the glass surface and from the scratching tool by thorough cleaning was necessary to get consistent and repeatable results; otherwise these materials lubricated the surfaces in contact and increased the load necessary for scratching. It is well known that lubrication is important in scratching glass by glass. Two bottles taken directly off the lehr, for example, will seize and scratch one another very easily when rubbed lightly together. If, however, the same bottles are allowed to stand in the open for a week, their surfaces will absorb enough foreign material to lubricate them and if they are rubbed together, seizure and scratching will not readily occur. An even greater lubricating effect may be obtained by rubbing the perspiration and natural oils from one's hand onto an otherwise fresh and clean bottle. From the nature of the processes responsible for the production of the scratches, it is to be expected that the cleanliness of the surfaces will likewise have an important role in the formation of chatter sleeks by blunt metallic points.

The glass therefore was cleaned, first by scrubbing with hot, soapy water and then by soaking in trisodium phosphate solution (3% NaOH equivalent) at 160°F. for 20 minutes, i.e., almost to the point that noticeable attack would occur on the glass surface. It was then washed in distilled water, dried in an oven, and tested shortly after being removed from the oven. The scratching point was also cleaned, and both the point and glass were handled with clean tongs in manipulating them. All of these steps were necessary to obtain the lowest values of the initial load for scratching, and the omission of any of them raised this figure; e.g., a final rinse by the laboratory tap water in place of distilled water would affect the result because the tap water is slightly contaminated with oil from the water pump.

## V. Scratching of Clean Dry Glass by Steel

The results obtained for several different forms of steel and iron are given. Of these samples, soft steel

| Sample No. | Steel | Initial load for scratching (kg.) |
|---|---|---|
| 1 | Soft steel (annealed) | 0.23 |
| 2 | " " (case-hardened) | .23 |
| 3 | Drill rod (annealed) | .28 |
| 4 | " " (tempered) | .20 |
| 5 | Cast iron | .23 |

(samples Nos. 1 and 2) is a low-carbon steel, one sample of which was case-hardened in fused cyanide; drill rod (samples Nos. 3 and 4) is a medium-carbon steel, which may be highly tempered; and cast iron (sample No. 5) has the highest carbon content of these samples.

All of these materials have about the same initial load for scratching, and whether or not the steel is annealed has little effect on this figure. This behavior may be connected with shear-hardening of the point, which takes place as material is removed from the point. Hardened or tempered steel, however, scratches more uniformly than annealed steel; it is more consistent in its behavior, and for the same load, it does more damage to the glass, possibly because there is less wear on the point in this case.

## VI. Scratching by Other Metals

Although different forms of steel give about the same initial load for scratching over a considerable range of hardness, other materials, which represent wider variations in hardness, give different initial loads (see Table I). The very soft metals, magnesium, tin, and lead, do not produce scratches in glass, but all of the others produce typical chatter sleeks. Figures 4 to 9 are photographs of the scratches produced by some of these materials. It is evident that there is a rough correlation between scratchability and hardness to the

extent that the very hard metals, such as iron and chromium, produce scratches at the lowest values of load and in general produce many more percussion crescents at comparable loads.

TABLE I

| Material | Initial load for scratching (kg.) |
|---|---|
| Chromium | 0.20 |
| Iron | 0.23 |
| Copper | 0.51 |
| Aluminum | 1 to 2 |
| Nickel | 1 to 2 |
| Brass | 1.2 to 2 |
| Zinc | 2 to 3 |
| Monel metal | 2 to 3 |
| Magnesium | No scratching |
| Tin | " " |
| Lead | " " |

Except for chromium, all of these materials leave metal marks on the glass. With the soft metals, e.g., aluminum, both the metal mark and the crescents are wider than those produced by the harder materials, such as brass and steel, owing to the greater width of the contact point of the soft metal. This squashing of the soft metal points was minimized but not eliminated by rotating as well as by redressing the point frequently.

It is obvious that any flattening of the soft metal points and the resulting increased area of contact with the glass will decrease the load per unit area of the point. In Table I, only the actual initial loads are given, but because the actual point areas are not the same, it does not give a comparison in absolute measurements between the scratchabilities of the various metals.

With hard metals, it is easily demonstrated that the initial load, to produce scratching by a sharp point, is less than that for a blunt point because of the different area of contact. It is apparent, however, that even if this correction were made the softer metals would still scratch less easily than the harder ones and the very soft metals would not scratch glass at all.

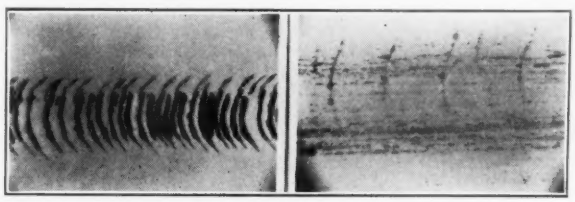


FIG. 4.—Typical chatter-sleek scratches formed by iron; *left*, etched; *right*, not etched.

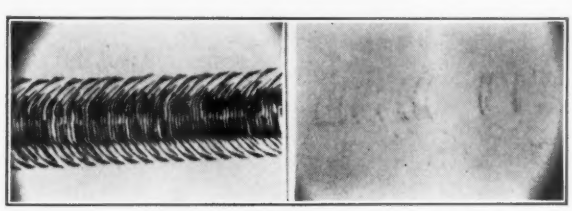


FIG. 5.—Typical chatter sleeks formed by nickel; *left*, etched; *right*, not etched.

## VII. Effect of Dirty Surfaces

The foregoing measurements were made with dry glass. Table II shows the results obtained with brass and steel and with clean distilled water on the surface of the glass. The behavior of glass that was cleaned only moderately well is also shown.

Whether the glass is wet or dry evidently makes a difference in the initial load, especially in the case of somewhat dirty surfaces wherein the effect of water is to lower the initial load. Brass is more sensitive than steel in this respect, and glass surfaces somewhat more lubricated than those described cannot be scratched by

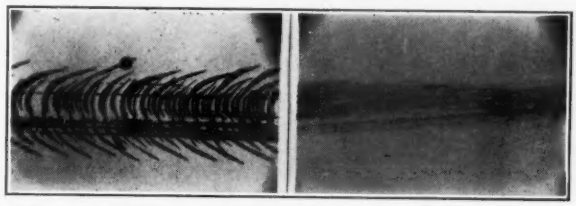


FIG. 6.—Typical chatter sleeks formed by chromium; *left*, etched; *right*, not etched.

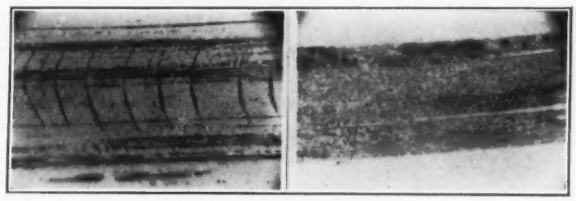


FIG. 7.—Typical chatter sleeks formed by zinc; *left*, etched; *right*, not etched.

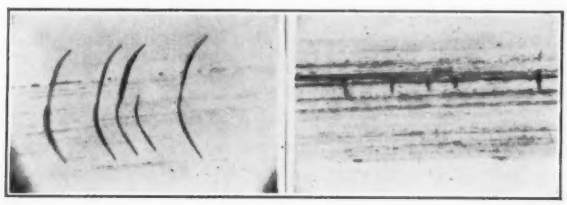


FIG. 8.—Typical chatter sleeks formed by aluminum; *left*, etched; *right*, not etched.

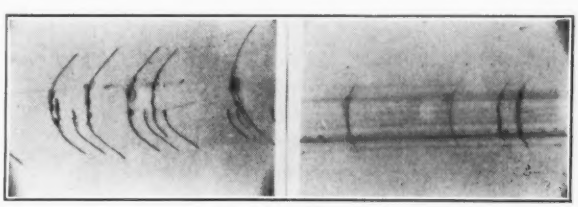


FIG. 9.—Typical chatter sleeks formed by brass; *left*, etched; *right*, not etched.

dry brass although they may be scratched by wet brass. Water probably helps to remove foreign material from the surfaces in contact so that a figure nearer the initial load for clean glass is obtained. In the case of clean glass, there is no effect with iron when water is put on the glass, but the initial load with brass is increased. This is just the opposite behavior, but it is possible that the water is contaminating the clean glass.

TABLE II

| | Condition of glass | Initial load (kg.) |
|---|---|---|
| Softsteel point | Dry, well cleaned | 0.23 |
| | " slightly dirty | .67 |
| | Wet, well cleaned | .23 |
| | " slightly dirty | .44 |
| Brass point | Dry, well cleaned | 1.2 |
| | " slightly dirty | 2.6 |
| | " brass oxidized | 3.2 |
| | Wet, well cleaned | 1.8 |
| | " slightly dirty | 2.0 |
| | " brass oxidized | 4.0 |

This work indicates that many soft materials will produce chatter sleeks in glass surfaces. The severity of damage as well as the initial load for scratching, in general, depends on the hardness of the material that is producing the scratch. It is also evident that lubricating films tend to prevent the formation of percussion crescents in the glass surface.

## VIII. Production of Chatter Sleeks

Because of the periodic recurrence of the individual crescents which make up a scratch of this type, vibrations both of the point and of the glass are involved in the production of these crescents. In a section of one scratch, there were about 400 crescents to the centimeter, and because the glass was moved past the point at a speed of about 1 cm. per second, the cracks were formed at a rate of 400 per second. Sound of this frequency may be heard as the tool passes over the dry glass. A very high pitched note is also often heard, but this probably is a natural frequency of the glass, which is excited by the lower vibration.

The energy and amplitude of the vibrations of the point depend in a complicated way on the geometry of the point and of the system supporting it. Because of the low frequency usually involved, the mechanical system supporting the point probably is contributing something to the amplitude of the vibration; at these frequencies, which are not far from the natural frequencies of the supporting system, the support cannot be rigid, but it must also undergo harmonic motion and, to this extent, reinforce the energy of the vibrating point.

It is evident, therefore, that the nature of the mechanical system holding the point as well as the dimensions of the point itself are important in determining the initial load at which scratching will occur and also the severity of the damage to the glass. This has been substantiated by the results obtained from a much lighter system, holding a much smaller point; with this system, the initial load with iron points was decreased from 0.23 to 0.025 kg. The figures in Table II, which gives the initial load for scratching various materials, are therefore relative only to one particular apparatus. They indicate, however, the relative initial loads and scratching powers of these materials in any reasonably similar mechanical system.

The theory has been advanced from time to time that friction between the two surfaces heats up a thin surface layer of metal in contact with the glass until it melts and sticks to the glass. It is supposed that the metallic point heats up and sticks and then pulls against the glass until a typical percussion crescent is formed. The frequency of the vibrations corresponding to the production of the percussion crescents should accordingly be determined, not by the mechanical system supporting the point, but by the refractoriness* of the point by the pressure upon it and by the speed at which the glass is drawn past the point. Because many metals having lower tensile strengths than glass can produce these crescents, the problem must be a dynamic one in which the inertia of the moving point is used to build up the forces required to break the surface. Inasmuch as the production of the chatter sleeks is essentially a dynamic process, the individual elements may be referred to as "percussion crescents."

The coefficient of friction between the point and the glass is important in getting energy into the vibrating system, and the melting of a thin surface layer, if it occurs, will influence the scratches to this extent. This, however, is only a means by which the coefficient of friction may be increased and not fundamental to the production of the crescents. The varying behavior of the softer metals is connected as much with their hardness and tensile strength, and possibly with their modulus of elasticity, as with their refractoriness.

The fact that glass, if clean, may be scratched by materials very much softer than itself is a matter of great practical importance. The fact that the scratches so produced are of the chatter-sleek type affects the subsequent course of events and the strength of glass in a very peculiar fashion. These matters will be discussed in a later communication.

PRESTON LABORATORIES
BUTLER, PENNSYLVANIA

* Bailey discusses the fusibility and refractoriness of glass, quartz, and abrasives, and calls attention to the fact that heating processes bring new factors into the scratching of glass surfaces, but he does not explicitly apply this idea to metallic scratching points (see footnote 3).

# ECONOMIES OF COMBUSTION CONTROL IN INDUSTRIAL CERAMICS*

By R. C. Hutchison

Abstract

One of the chief objects of this study has been to show the fuel waste through excessive use of air or of time in firing ceramic ware. It also suggests the economic benefit that may be derived by control of these excesses as well as by the use of waste-heat boilers.

## I. Introduction

The firing of ceramic ware requires the absorption of fairly definite quantities of heat to do the required amount of heat work, which must neither be applied faster than the ware can absorb it nor too slowly, which would result in excessive stack losses. Temperature is an essential factor; although it may be possible to fire for a longer time, the temperature has a greater effect than the time. Within the limits of the ability of the ware to absorb, the faster the heat is applied, the more economical will be the operation. Moisture that may be in the ware will be effective to a large measure in decreasing the rate at which the heat may be applied. During this period, air in excess of that required for combustion must be used, but the volume of the product of combustion should be large enough to prevent condensation of the water vapor present. As the firing progresses to the stage where all combustibles are ignited, unless air is present in excess of that required for combustion of the fuel, black core and bloating of the finished product may be expected.[1] Both of these periods require excess air; if, however, quantities or time in excess of that required for the completion of the work are used, they will be reflected directly in firing costs.

After the moisture and combustibles have been removed, it is no longer necessary to maintain excess air. Firing, therefore, should be conducted along the lines most advantageous to combustion and according to the ability of the ware to absorb the heat. In most cases, and this is particularly true with refractory materials, a slightly reducing atmosphere will usually lower the maturing temperatures and thereby lower the total heat work required.

In view of the many heat economies and methods of combustion control used by the steel industry, it seems logical that some of these could be applied to advantage in the ceramic industry. This has been done in a number of ceramic plants. As an example, an electrical porcelain plant reduced firing costs in a tunnel kiln by 10% by the use of daily Orsat analysis of flue gases. The same plant, using both Orsat analysis of flue gases and time-temperature studies, was able to reduce fuel consumption by 40% in its periodic kilns and the firing time by 57%.

In 1923, the Bureau of Mines made a survey in the refractories field and demonstrated that, at the seven plants visited, it would be possible to reduce the average firing time by 19% with an average fuel saving of 13.5%.[2]

## II. Excess Air and Oxygen in Flue Gas

With certain data obtained by the Bureau of Mines, the relation between excess air and oxygen in flue gas may be used for comparison (Fig. 1). If a sample of flue gas contains 12% of oxygen, find 12% of oxygen at the bottom of the chart, project upward until it strikes the curve at point *A;* project to the left from this point, where it will be found that 12% of oxygen in the flue gases means 132% of excess air. In effect,

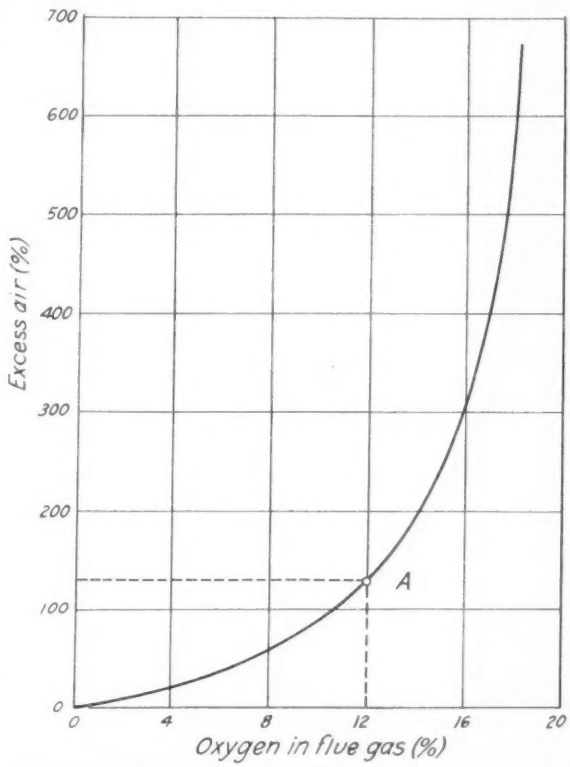



Fig. 1.—Relation between excess air and oxygen in flue gas. The curve applies to a particular coal; the same general shape of curve is obtained for other fuels.

* Presented at the Forty-Second Annual Meeting, American Ceramic Society, Toronto, Canada, April 8, 1940 (General Session on Kiln Firing). Received April 8, 1940.

[1] F. G. Jackson, "Oxidation of Ceramic Ware During Firing: VII, Review," *Jour. Amer. Ceram. Soc.*, **14** [7] 225–29 (1935).

[2] G. A. Bole, John Blizard, W. E. Rice, E. P. Ogden, and R. A. Sherman, "Problems in the Firing of Refractories," *Bur. Mines Bull.*, No. 271, 197 pp. (1927); *Ceram. Abs.*, **6** [9] 395 (1927).

this means that two and one-third times the required volume of air to burn the fuel is being passed through the kiln. Obviously, this extra one and one-third volume of air must be heated up to kiln temperature and then eventually discharged to the atmosphere. It has accomplished no work, in most cases, and therefore the fuel that was required to heat it to the temperature of the flue gas was wasted.

The quantity of heat carried off varies with the temperature and the volume of the flue gas. Figures 2, 3, 4, and 5 represent the sensible heat in B.t.u. per pound of coal at four stack temperatures, namely, 340°, 580°, 1220°, and 2280°F. These stack temperatures are average temperatures for the first, second, third to fourth, and fifth to ninth days, respectively, for kiln 2B in the Bureau of Mines survey. On these curves, line *A–D* on each represents the sensible heat in B.t.u. per pound of coal carried off through the stack with different percentages of excess air and discharged to an atmosphere of 60°F. Line *B–E* on each represents the total combustibles and the sensible heat that go to the stack, the latter being represented by *A–B*. Lines *F–H*, on each curve, represent the remaining theoretical B.t.u. per pound of coal after charging off stack losses.

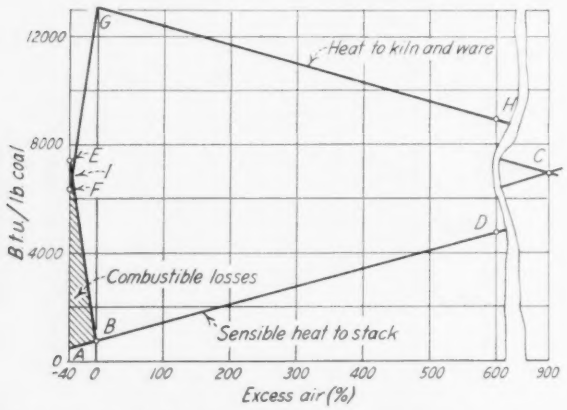



FIG. 2.—Heat distribution in B.t.u. per pound of coal; stack temperature, 340°F.

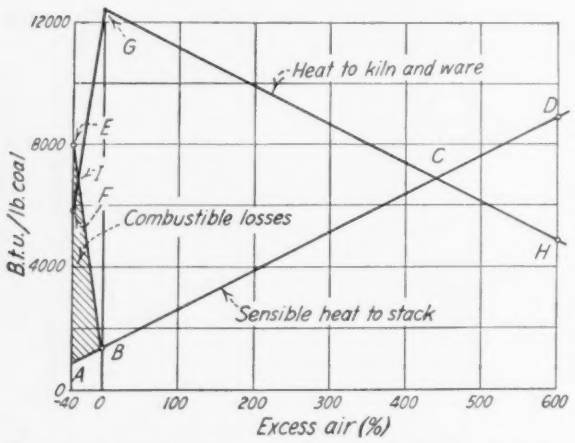



FIG. 3.—Heat distribution in B.t.u. per pound of coal; stack temperature, 580°F.

Points *I* and *C* are of special interest as they indicate where half of the total B.t.u. in the coal are carried to the atmosphere either through deficiency in the air or in excess of that required for combustion. Note how these approach the point of perfect combustion as the stack temperatures rise. In Fig. 2, 50% of the fuel input is lost by a 35% deficiency or a 900% excess of air, whereas at 2280°F., only 4% deficiency or 10% excess of air results in a 50% fuel loss.

## III. Economy of Shorter Firing Periods

It will be noted from these curves that, as the stack temperatures increase, the B.t.u. per pound of coal available for useful work with perfect combustion decreases. Nearly half of the available heat in the coal goes up the stack when the temperature approaches 2280°F. Figure 6 represents the probable economy of shorter firing periods. Curve *A–C* represents the firing rate of a kiln, fired to 2680°F. and soaked until uniform temperatures are obtained; curve *E–F* rep-

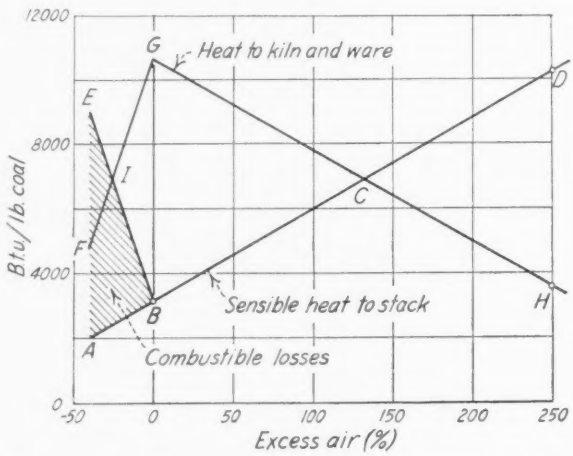



FIG. 4.—Heat distribution in B.t.u. per pound of coal; stack temperature, 1220°F.

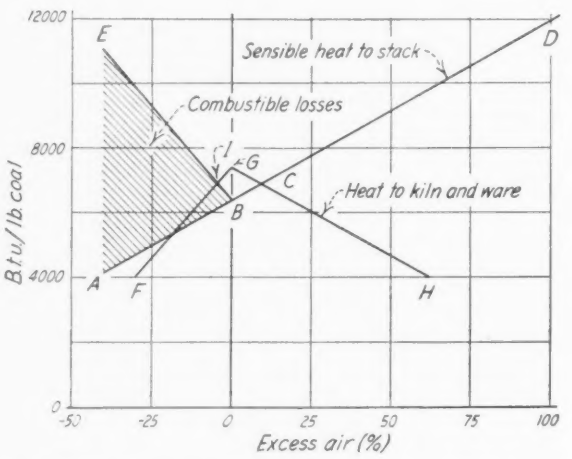



FIG. 5.—Heat distribution in B.t.u. per pound of coal; stack temperature, 2280°F.

resents the cumulative coal consumption in tons. Curve *A–D* represents the firing rate of the same kiln but fired to 2580°F. for a total of $11^1/_2$ days instead of $8^1/_2$ days; curve *E–G* represents the total coal consumption with the lower maturing temperature. In effect, the theoretical consumption would be increased 33%. Unless a decrease in kiln losses or improved finished product justifies this practice, it should not be followed.

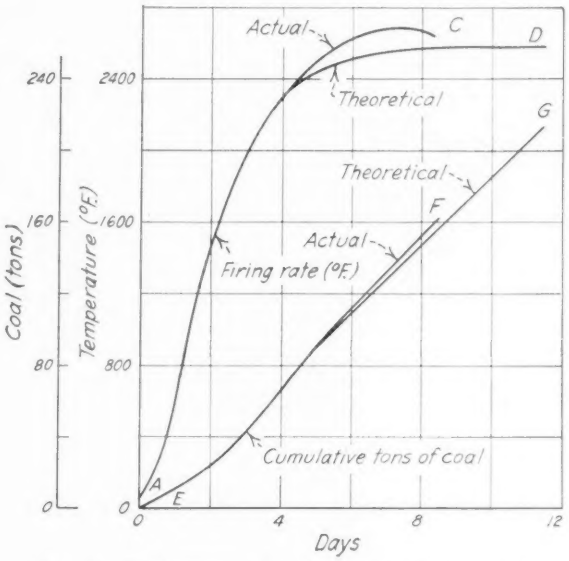



FIG. 6.—Fuel economy by shortening firing period.

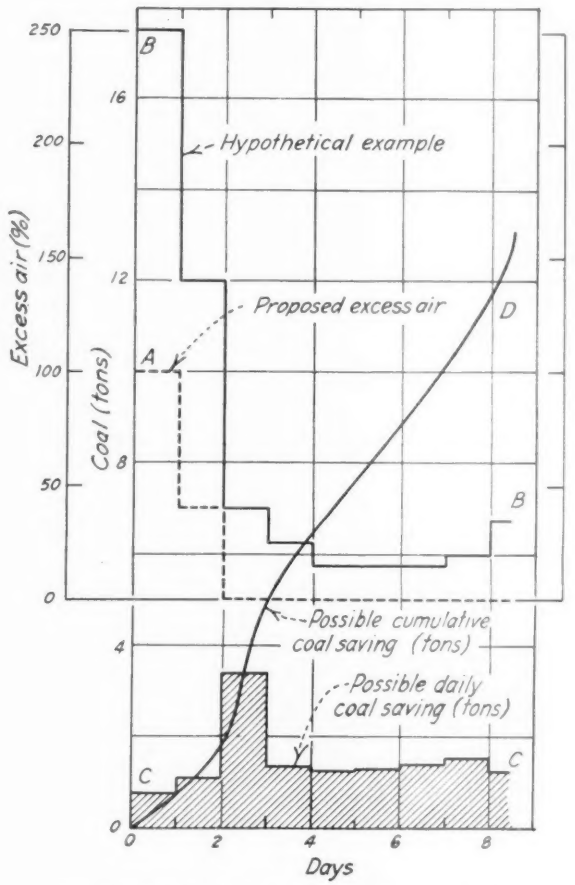



FIG. 7.—Fuel saving by regulation of excess air.

## IV. Economy in Control of Excess Air

Unless there is close control of excess air used in firing a kiln, needless wastes of fuel will be encountered. Figure 7 demonstrates how additional volumes may affect fuel consumption. These volumes perform a definite function, which requires a definite quantity of air and time. Curve *A* suggests allowable excesses; *B*, a hypothetical example in which extremes of both air and time were used; *C* represents tons of fuel required daily to heat the additional volumes of air to stack temperature; and *D* shows the possible cumulative coal saving in tons. These curves clearly demonstrate the necessity of combustion control, and, if control is lacking, how it will be reflected in coal consumption.

## V. Economy in Waste-Heat Boilers

Even if perfect combustion is maintained, approximately half of the total B.t.u. input to the kiln escapes to the stack, and these B.t.u. have done no useful work. The most practical means of salvaging this heat would be through the use of waste-heat boilers, providing there is sufficient quantities of and a use for steam. There are many outstanding examples of this application of waste-heat boilers in other industries. Taking a plant in the steel industry in which the steam demand is 25,000 boiler h.p., 41% (or 10,250 boiler h.p.) is generated by waste heat from open-hearth furnaces and blast-furnace gas engines. The copper industry in 1902 was using waste-heat boilers and accounted for 54% of its total B.t.u. input in reverberatory furnaces.[3] Waste-heat boilers recovered 60.75%

[3] Frederick Laist, "History of Reverberatory Smelting in Montana," *Trans. Amer. Inst. Mining Met. Engrs.*, **106**, 61 (1933).

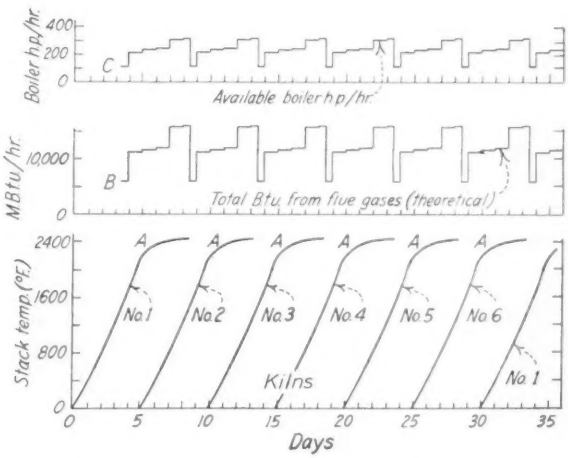



FIG. 8.—Kiln schedule showing possible waste-heat recovery.

and the remaining 39.25% was consumed by work done in the furnace. This list could be continued indefinitely.

It is feasible to use waste-heat boilers with kilns fired intermittently. The most economical way to do this would be to connect a number of kilns to one boiler. A plant with fifteen to thirty kilns could use six of these kilns, scheduled so as to effect a fairly constant supply of waste heat, as shown in Fig. 8 (curve *A*). Steam generation can be justified from 1000°F. flue gases. On this basis and with no attempt to reclaim any heat from the cooling kiln, there would be 11,238,000 to 16,235,000 B.t.u. per hour and a 12-hour interval every five days of only 6,154,000 B.t.u. available (curve *B*). If no heat could be reclaimed from the cooling kiln, auxiliary oil burners could be provided to boost boiler output during this period for power-load demands. Curve *C* represents the hourly boiler h.p., based on the recovery of 65% of the total hourly stack loss. Based on one 220-boiler h.p. per hr. unit and on coal at $4.00 per ton, a saving of from $10,000 to $14,000 per year would be realized.

The points which have been developed in this paper demonstrate how fuel savings might be made by (1) careful studies of the relation of time and temperature to the product, (2) a more careful control of combustion, and (3) recovery of heat from the flue gases by waste-heat boilers.

Bethlehem Steel Company, Incorporated
Bethlehem, Pennsylvania

# REFRACTORIES USED IN HIGH-FREQUENCY ELECTRIC MELTING OF STEEL AND ALLOYS*

By B. W. Magalis

Abstract

A description is presented of the use and types of induction furnaces as well as the requirements of the refractories used in their linings. Three methods are described for lining coreless induction furnaces. Acid ganister and basic linings are also described, and the process for using several miscellaneous types of linings is given. The importance of the selection of refractories for high-frequency electric melting of steel and alloys is emphasized.

## I. Introduction

An induction furnace is essentially a transformer, the secondary of which is the molten metal or the metal to be melted. The two principal types are the ring or core type and the coreless type, the latter being commercially the most important in ferrous melting. The coreless furnace consists usually of a helical inductor coil or primary winding and a cylindrical crucible of refractory material located inside the coil. This type of furnace is generally operated with high-frequency currents. It may vary in size in this country from small laboratory units of a few pounds capacity up to a maximum of 8000 pounds. Commercial units in the steel-casting industry will average 1000 to 1500 pounds capacity. Figure 1 shows a unit of this type.

## II. Requirements of Refractories for Induction Furnaces

It is apparent that for highest electrical efficiency the refractory thickness must be kept as small as possible, which imposes the first limitation in consideration of refractories for this furnace. At the same time, this relatively thin refractory crucible must withstand normal operating conditions, which are severe in some respects. For example, the furnaces are usually of the tilting type, and the thin refractory must withstand the strains imposed by the weight of the metal during pouring. The crucibles, furthermore, generally have a large ratio of height to diameter, and the charging operation imposes severe abrasion and shock loading on the crucible.

To avoid eddy losses in the supporting frame, strong metallic members are avoided, and the frame in most

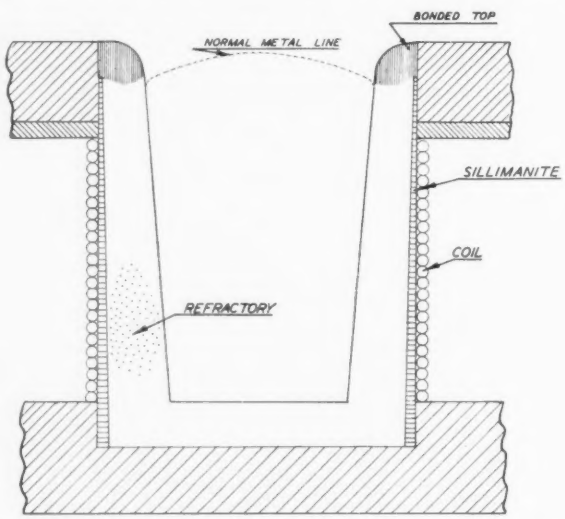



Fig. 1.—General arrangement of coreless induction furnace.

* Presented at the Refractories Division Autumn Meeting, Conneaut Lake, Pa., September 9, 1939. Received January 18, 1940.

cases is built of asbestos wood, a relatively weak structural material. Refractories which tend to high volumetric expansion in service, therefore, must be avoided.

In induction-furnace practice, melting of the charge proceeds rapidly and high thermal gradients are imposed on the refractory not only through its thickness but along its height. For example, in melting down, superheated molten metal may exist at the bottom of the crucible and its top will be in contact with cold scrap. Even when the melt has attained a uniform temperature, a temperature gradient exists through the refractory thickness by reason of the water-cooled inductor coil surrounding the crucible.

Induction furnaces in the steel industry are generally used for melting many different types of alloy steels, and the refractory must be suitable for melting in succession many different alloy steels without excessive reactions proceeding between the refractory and metal slags. The refractory must be resistant to excessive fluxing around the contact line between the slag and metal bath, a condition especially prevalent in the induction furnace with its continual stirring of the melt.

These are the requirements, in general, of refractories for induction furnaces in steelmaking. From a practical viewpoint, however, the various methods of installing refractories which have been successfully evolved are also important. It should be recorded that the refractories problem was the most difficult one in the successful commercial development of the coreless high-frequency furnace.

## (1) Linings for Coreless Induction Furnaces

To date, there are three well-known methods employed for lining coreless induction furnaces. In method No. 1, the lining material is mixed with a bond and rammed between the coil and a central form (Fig. 2). The form is then removed and the green lining is dried. Such drying may be conveniently done with electric heaters, wood or charcoal fires, or gas or oil torches. There is obviously no reason why an induction-heated graphite core could not be used even to the extent of sintering the outer skin. This method will work well with acid linings, but it is unsatisfactory for basic materials.

Method No. 2 employs the use of an asbestos cylinder closed at the bottom (Fig. 3). This cylinder is located centrally within the coil and placed on the dry lining material which has previously been tamped on the furnace bottom. The refractory is now packed in around the asbestos cylinder to a height a little above the level of a full charge of molten metal. The remaining distance to the top of the furnace is filled in with a slightly dampened and highly bonded material that soon hardens. The first charge, preferably of small pieces of metal, is placed in the furnace and melted down. When all of the metal is melted, the asbestos cylinder will have completely melted and will float on top of the bath as slag which may be easily removed. This method is generally employed where basic materials are involved.

In method No. 3, a clay-bonded magnesite crucible is placed inside the coil, and the space between the coil and the crucible is packed with magnesite flour (Fig. 4). On induction heating of the charge in the crucible, the magnesite sinters on the outside of the crucible, forming a lining thicker than the original crucible. This method, however, is limited by the difficulty of making and handling large crucibles of materials, such as magnesite, and is seldom used in lining commercial-size units. Methods No. 1 and No. 2, which are in general use, are described in detail.

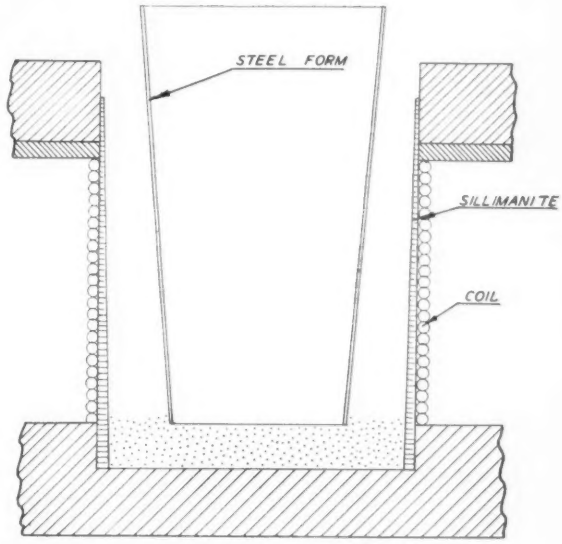



FIG. 2.—Coreless induction furnace with bonded rammed lining showing use of method No. 1.

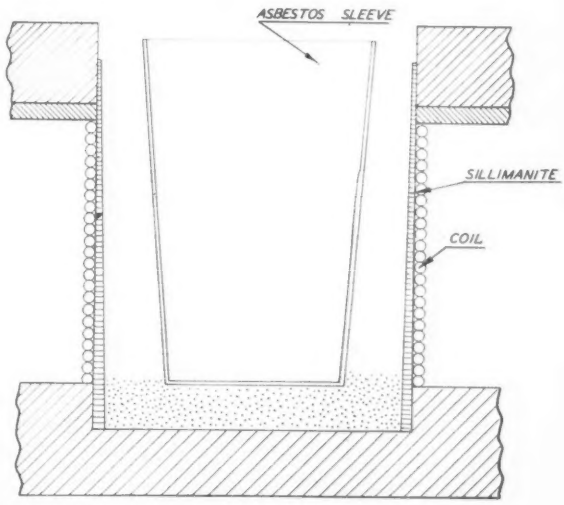



FIG. 3.—Coreless induction furnace with dry refractory lining showing use of method No. 2.

## III. Acid Ganister Lining

Assuming that the furnace has been cleaned and is ready for lining, the inside surface of the spiral copper coil is coated with a troweling mixture of any good refractory material, such as sillimanite, which should not be applied over $^3/_8$ inch thick. This coat must

have a smooth surface and be thoroughly dried. This smooth, plasterlike, refractory serves a double purpose because it will protect the furnace coil from being damaged by molten metal in the event of a lining failure and because, if applied with a slightly increasing diameter toward the furnace top, it will allow the lining to grow upward with less chance of clinging to the coil or any irregularities therein, which ultimately causes the furnace frame to fail by cracking.

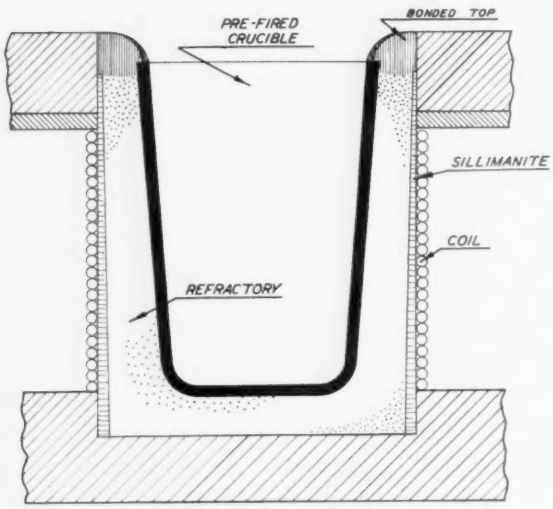



FIG. 4.—Coreless induction furnace with prefired crucible lining showing use of method No. 3.

Sufficient silica flour is added to a commercial ganister to give the following (approximate) sieve test (Table I).

TABLE I

TYPICAL GRADING OF ACID-LINING MATERIAL

| Sieve sizes | (%) |
|---|---|
| On 20-mesh | 24 |
| Through 20- and on 60-mesh | 26 |
| " 60- " " 120- " | 21 |
| " 120-mesh | 29 |

These dry materials are thoroughly mulled. The dry mixture is then moistened to a ramming consistency with a 3 to 1 solution of water and silicate of soda. This mixture is placed on the furnace bottom and rammed to the required depth, usually 3 or 4 inches.

A steel or wood form is placed on the rammed bottom and centered, after which the lining mix is packed in around the form to a level slightly above the furnace metal line. From this point to the top, the lining must be hard and tough to withstand charging and skimming. These qualities are obtained by using the regular mix moistened with a stronger solution of silicate of soda or by using a mixture of good silica sand mixed with 30% of fire clay.

After the ramming in of the lining is complete, the form is withdrawn and a light wood fire is kept on the furnace bottom for about two to four hours. The furnace may then be charged and the melting started.

Such a ganister lining is not as refractory as some made from basic or neutral materials, but it will stand temperatures up to 3000°F. This limiting temperature is sufficient for most steel-foundry melting and, with proper handling, will give more than 100 heats of miscellaneous alloy before a complete new lining is installed. Patching is required after 8 to 15 heats and is done by first cleaning the area to be repaired of all slag or metal particles. The cleaned area is then painted with a slurry made of ganister, silicate of soda, and water followed by applying to the required depth the ganister ramming mix, which is tamped in place with a wooden mallet or in some cases by hand. More than 5000 heats, ranging in size from 400 to 8000 pounds, have been made with ganister linings in use, and the writer states that not a single lining failure has been directly chargeable to an inherent lining defect.

## IV. Basic Linings

The larger percentage of the magnesite linings at the present time is installed by the dry method, No. 2. After the interior of the furnace coil has been troweled smooth with the high-temperature cement and dried, the furnace bottom is filled to the desired level with the dry magnesite. A tapered asbestos sleeve, or form, which has been closed at the bottom with a suitable disk either of asbestos or steel, is set in place. Magnesite, graded as in Table II, is then rammed between the sleeve and coil up to the top zone where silica of soda is used to give a hard, shock-resisting material.

TABLE II

TYPICAL GRADING OF BASIC LINING MATERIAL

| Sieve sizes | (%) |
|---|---|
| On 20-mesh | 22.0 |
| Through 20- and on 60-mesh | 32.0 |
| " 60-mesh | 46.0 |

The furnace is now charged, and the heat is melted in the usual manner. As the molten metal rises in the furnace, the asbestos sleeve disintegrates and floats on the surface as slag.

Basic linings, so prepared, are highly refractory and commonly run 30 heats before they require patching. They are, however, likely to crack, possibly owing to the very shallow sinter depth and also to brittleness. Magnesite linings furthermore have a tendency to grow, causing mechanical failures throughout the furnace frame and lining trouble, owing to this sudden growth of the refractory.

## V. Miscellaneous Refractories

A prepared mixture of alumina and magnesia, both electrically fused, has been used with considerable success. This material is approximately 60% of magnesia and 40% of alumina and fully meets the requirements of a good coreless induction-furnace lining. For furnaces operating on an intermittent schedule, however, some difficulty will be experienced with cracking. It has been reported that one user, operating 2500-pound furnaces and melting low-carbon 18–8 type stainless steel,

runs 50 to 60 consecutive heats with alumina-magnesia refractory linings, during which time no patching is required.

Zirconium silicate, 40- to 90-mesh, plus 15% of flour, installed dry, was reported by another user to be excellent for 5 to 10 heats, after which an extreme softening of the surface took place. Failure was attributed to iron-oxide penetration.

A user melting a wide variety of alloy steels, including alloys containing aluminum and other elements that had been quite reactive with silica, prefers to use a neutral refractory rather than a furnace lined with either ganister or magnesite. For this purpose, he uses a pure, calcined aluminum oxide. The lining of aluminum oxide is made by method No. 2, utilizing the steel shell. This user advises that linings made in this manner show inappreciable shrinkage or expansion under intermittent service. Excellent service life is obtained up to 200 heats without relining. For patching such a lining, the same material, that is, aluminum oxide, is used and bonded with foundry-core compound and water.

## VI. Summary

High-frequency induction furnaces are relatively small consumers of refractory materials, as the overall tonnage of steel produced in them is but a fraction of the tonnage of the electric-furnace steel produced. By reason of certain limitations, however, imposed on the refractory resulting from the construction of such furnaces, the problem of suitable refractories has been, and is today, a particularly troublesome one. Like all other developments, the method of installing refractory linings and the choice of refractory linings have been a matter of evolution in which different users have worked out their own problems and, in many cases, have arrived at a definite choice of the most suitable refractory. This choice, however, depends to a great extent on the use to which the furnace has been placed. For example, the refractory problem in a furnace of more or less continuous operation on the same type of steel is somewhat different from the problem of a furnace melting a relatively large number of different types of alloys and under intermittent operation. The author has found that for his particular service a ganister lining rammed in around a mold offers the most economical lining, not only from the viewpoint of cost of material but also from that of the available number of heats before relining is required. Others, however, find a neutral aluminum oxide or corundum refractory to be the most satisfactory or that a magnesite lining or an alumina-magnesia lining is the most suitable for their purposes.

Although the use of an untried refractory might lead the user into an expensive breakdown if the refractory should give way and allow the melt to reach the induction coil or auxiliary leads, it might be stated that induction-furnace operators generally are willing to test such refractories as the industry may suggest with the viewpoint of bettering present performance, and operators will greatly appreciate the further cooperation of the refractories industry.

The Babcock and Wilcox Company
Alloy Steel Division, Barberton Works
Barberton, Ohio

# CERAMIC HISTORY

## LEWIS P. REESE

By E. D. Shumaker

This is the story of one of the remarkable accomplishments in the ceramic industry. It is a story of success amid the ruins of failure, the story of amazing achievement against the odds of business depression. And, because achievement is the product of human endeavor, it is the story of a man—the story of Lewis P. Reese and his meteoric rise to fame and fortune.

The story begins in a two-room log cabin in a tiny Ohio hamlet. Here Lewis Paul Reese was born, February 28, 1893. Almost bare of furniture, the little two-room cabin was the typical pioneer's dwelling, but it served for two years as a home to the infant Lewis, his brother, two sisters, and parents. In 1895, the elder Reese, compelled by force of circumstances, moved his family to the oil fields near Sistersville, West Virginia, where he attempted to make a living as a teamster. Here again, circumstances intervened and he was forced to find a home for the family on a dilapidated farm near Waverly, West Virginia.

It was in this locality that Lewis started to school. One of fourteen pupils housed in a one-room schoolhouse, he was taught reading, writing, arithmetic, and spelling.

At the age of fourteen, Lewis accompanied his father on a visit to an uncle in Newell, West Virginia. Lewis recalls this trip as one of the most thrilling events of his life because it was his first ride on a train. At this time, plant No. 4 of the Homer Laughlin China Company had just been completed, and labor was much in demand. Lewis was offered a job as dipper's helper at what seemed to him then the magnificent salary of sixty cents a day. He accepted, and then and there entered the industry that was to bring him fame and fortune twenty-five years later.

That was at the beginning of the summer vacation in 1907. Lewis worked at the pottery for two summers, resuming his schooling each winter. His father sold the place at Waverly and rented a dairy farm near Chester, West Virginia. Halfway through the winter of 1908–1909, his father became ill and Lewis was compelled to leave school to work on the farm. But despite the youthful farmer's efforts, the income from the farm dwindled and it soon became evident that other means of supporting the family would have to be found. At the age of fifteen, therefore, Lewis returned to the trade of pottery making. His job this time was "balling-in" cups at the Trenle China Company, East Liverpool, Ohio, across the river from his home.

In the words of Lewis himself, "I was pretty green when I first started to work at the Trenle pottery. Almost the first day on the job I demonstrated my lack of familiarity with the ceramic processes. I smelled wood smoke. 'Place must be on fire,' I thought, and dashed downstairs. 'Hey, Mr. Trenle,' I shouted, 'there's a fire in the building.' 'Sure, it's in the kiln,' said Gus Trenle. So I rushed to the kiln to help put it out. I'll never forget my embarrassment at finding that the 'fire' was there on purpose—to fire the ware. Nor will I ever forget the ribbing I got from the rest of the boys."

Young Reese worked at this job for about a year, when he was promoted to the classification of mold runner. This, his first promotion, carried with it an increase in wages to $1.25 a day. In the meantime, the family had moved to Dixonville, Ohio, a suburb of East Liverpool. The father became too ill to leave the house, and the entire burden of supporting the family fell upon the young pottery worker's shoulders. The promotion and increase in wages eased the burden somewhat and gave Lewis a measure of confidence in himself. Throughout the following years and a succession of jobs, this feeling of confidence never left him. He was constantly inspired by an ambition to better himself and regarded each position as a stepping-stone to his final destiny. He worked in various capacities at the Homer Laughlin plants Nos. 1 and 2, W. S. George Pottery Company, Harker and Cartwright potteries, and the Edwin M. Knowles China Company. His apprenticeship as a jiggerman began at the Globe Pottery, continued at the McNicol and Corns Pottery Company, and was completed at the Trenle China Company.

In 1917, the United States entered the World War and Reese joined the Army. He was sent to France with the American Expeditionary Force, served with the 18th Field Artillery in the 3rd Division, and spent five months in Germany with the Army of Occupation.

The turning point in Reese's career came at the Edwin M. Knowles China Company. Plant superintendent Harry Watkins had noticed the young man's absorbing interest in his work and his evident desire to perfect his skill. Watkins told him that if he would apply himself, complete his education, and learn the theoretical as well as the practical side of his trade, he would advance rapidly in the pottery industry. The result was that Lewis enrolled in a ceramic class at Newell, West Virginia. His instructors were J. W. Hepplewhite, ceramist of the Edwin M. Knowles China Company; A. V. Bleininger, ceramist of the Homer Laughlin China Company; Robert Miller, ceramist of the Knowles, Taylor, and Knowles Company; and "Vic" Roehm, of Taylor, Smith and Taylor. The many long hours of patient teaching by Mr. Hepplewhite showed results, for soon Mr. Watkins recommended him for a job as foreman in the newly constructed New Cumberland plant of the Cronin China Company.

For five years, Reese devoted every moment of his spare time at the Cronin Pottery to experimentation and research. His employers gave him every encouragement and a free rein to put many of his ideas into practice. Many times the experiments failed to produce the expected results and frequently the task seemed hopeless. But the pioneering instinct passed on to him by his parents gave him the courage to persist. The ultimate goal of all his pioneering work was to make a better product and to make it quicker and cheaper. Basic processes in the ceramic industry had changed but little in many centuries. Much of the work was still done by hand, slowly and laboriously. Labor-saving machinery was accepted reluctantly and mass pro-

duction, such as had revolutionized other industries, was unknown in ceramics. After centuries of development, it still took at least three weeks from the clay pile to make a piece of pottery.

Reese pondered this problem day and night. He saw many opportunities for cutting down time between the mixing and the final cooling after firing. Gradually the idea took form. Why not a circular kiln for continuous operation, with conveyers similar to the production lines in an automobile factory?

He broached the subject to several of his friends. They not only declared that the scheme would never work but added that he "must be crazy even to think of it." Reese, however, was convinced it would work, and he knew that he "had something there."

Reese resigned his position at the Cronin China Company in 1932. It was at the beginning of a severe depression, and thousands were tramping the streets looking for work of any kind. Reese knew of an abandoned pottery at Scio, Ohio, and decided he would pay the town a visit and find out why the pottery had failed. Hunting is Reese's favorite sport, so he made arrangements with some Scio friends to hunt rabbits in the vicinity of the abandoned pottery.

The story of that rabbit hunt is indelibly inscribed in the archives of Scio. It is an oft-told tale in the councils of that once decadent village. It is the story of a hunt that bagged no rabbits but revived a dead industry and brought prosperity to an impoverished town.

The hunt got no farther than the abandoned pottery. Reese led his friends in a brief examination of the tumbledown buildings. It was the ideal setting in which to carry out his ideas. With a small expenditure of money and a very large expenditure of energy, the plant could be rehabilitated and put in operation in a very short time.

The plant had been closed for several years, and, since it had been the town's only industry, property values were rapidly declining to the vanishing point. The population had fallen from 1200 to 400 in five years. Many of the houses were vacant and could have been bought for a fraction of the cost of construction. Scio was about to give up the ghost. Consequently, when Reese appeared on the scene, he found a receptive and attentive audience for his plans.

Reese, out of a job, was almost penniless. But by borrowing on his War Risk Insurance, he was able to raise $2000. Back taxes amounted to $3600, but this, he was informed by local authorities, could be paid off in installments. A meeting was held and the bondholders of the old company, enthusiastically approving Reese's plans, agreed to accept stock in the new company in exchange for their bonds. The property was knocked down at sheriff's sale for $8000, and, in November, 1932, with the friendly advice and cooperation of Reese's former employer, Dan Cronin, the herculean task of renovating the ghost pottery began.

The town's most prominent citizens donned overalls and pitched in—merchant, doctor, minister, bank cashier, school principal, dentist, and the former pottery workmen. They repaired the leaking roof, replaced broken windows, cleared away rubbish, and rebuilt the road. Reese fixed up a corner for living quarters, and from Thanksgiving Day, 1932, until March, 1933, he and six volunteers ate and slept in the unheated plant. For six weeks they worked fourteen to eighteen hours a day. By February they had completed the circular kiln and conveying system embodying Reese's ideas for continuous mass production. It was a labor of hope, for no wages were paid during this period. All these volunteers had was the promise of work and a steady income if the project succeeded.

With the plant ready for production, Reese sold the first carload of whiteware, yet to be produced, to Butler Brothers, who continue to be one of Scio's best customers. Materials suppliers, who knew about Reese's plans and believed in him, extended credit for the first shipment of clay and other materials. Production started in mid-February, 1933. The first payroll fell due on the twenty-third. Reese had a cash balance of exactly 11 cents! There was a huddle in the back room of the bank and twenty men put in $100 apiece and the payroll was met. A week later the first carload of whiteware rolled out of the plant, and the Scio-Ohio Pottery Company, as it was named, has been in continuous operation, twenty-four hours a day, without shutdown, ever since.

Lewis P. Reese had achieved the seemingly impossible. He had done what others had told him could not be done. He had introduced mass-production methods into the pottery industry. He had combined the traditional two firings into one. He had reduced the time of producing a cup, from clay to shipping platform, from the usual three weeks to eighteen hours! He had discovered how to make a whiteware cup that could be retailed at five cents. By streamlining production methods, he had discovered how to meet the cheap competition of Japanese labor.

Employees of the Scio Pottery have had the good fortune to enjoy steady employment for the seven years the plant has been in operation. This, coupled with a wage scale, ranging from a minimum of fifty cents an hour to as high as $1.75 an hour, makes for a high standard of living in the community. "L. P.," as he is affectionately known among his employees, is still regarded more as a fellow worker than as a "boss." He is just as apt to be found working around the plant with jiggermen, ballers-in, and kiln-tenders as he is at his desk in the factory office. He knows every one of his five hundred employees personally. Practically all of the special machinery in the plant, designed and patented by Reese, has been installed to make work either safer or more pleasant. The plant operates a restaurant at which good wholesome food is served at cost to the employees. Tennis courts, shooting ranges, and other recreation facilities are maintained for the free use of the public as well as the employees. Mindful of the part education played in his own climb to success, "L. P." has established ceramic classes and opened them free-of-charge to all who wish to attend.

That the Scio experiment in mass production of whiteware is a success is amply evidenced by the sales figures. In 1934, the first full year of operation, the plant did a gross business of $331,000. In 1938, the figure was well over a million dollars. In 1939, the plant produced more than twelve million cups in addition to a general line of white dinnerware.

Scio products are sold to large chain stores and jobbers in the United States and its possessions. Before 1933, no five-cent cups could be had, except those made in Japan.

Domestic manufacturers could not compete with the low manufacturing costs of the Japanese. Now virtually every chain store in America is buying Scio products. Reese had found what he had been searching for, a way to make *better* whiteware in *less* time at *lower* cost. He is happy, and the town he favored is again a thriving, prosperous healthy community of 1400 population. Reese takes special pride in the fact that he has been able to help many of his employees obtain homes and farms of their own.

An ardent sportsman, Reese makes a hobby of big-game hunting. In the offices of the Scio Pottery is mounted an astonishing collection of his trophies—mounted heads of grizzly bear, mountain goats, moose, elk, and many another specimen of big game, all bagged by Reese and his employees in various parts of the United States and Canada. Although an expert marksman with either rifle or pistol, Reese still maintains that he would rather hunt game with a camera than with a gun.

Reese, like all men of genius, is a modest man. Asked to explain how he succeeded in the face of apparently insuperable obstacles, he waves a self-depreciating hand toward his employees and says,

"I couldn't have done it without their loyal help and the faith of friends."

Reese's friends, however, know that it was something more than loyal cooperation that brought success to the enterprise. They know it was not luck. Opportunity comes to every man, but not every man recognizes it. Reese did. The abandoned pottery lay there like an acre of diamonds in the town's own backyard. Many a man had passed it, as Reese did on the day of his famous "rabbit hunt." But, unlike the others, Reese had the imagination to see its great possibilities. Where others saw nothing but an empty shell, a decaying pile, Reese pictured a thriving factory with hundreds of busy workmen, turning out pottery on the endless belts of mass production. He brought to his project the enterprise and initiative necessary to set his plans in motion and the abundant energy and courage that saw them through to completion.

Pressed for his formula for success, Reese quotes from an old, yellowed newspaper clipping a statement attributed to the late E. H. Harriman, railroad magnate:

"To achieve what the world calls success, a man must attend strictly to business and keep a little in advance of the times.

"The man who reaches the top is the one who is not content with doing just what is required of him. He does more.

"Every man should make up his mind that if he expects to succeed he must give an honest return for the other man's dollar.

"Grasp the idea and work it out to a successful conclusion. That's about all there is in life for any of us."

# FORTY-THIRD ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY

## BALTIMORE, MARYLAND, MARCH 30 to APRIL 5, 1941

## OLD BOW PORCELAIN IN THE WALTERS ART GALLERY

A story is told by Chaffers about the Bow porcelain factory that makes Bow porcelain of especial interest to Americans. The first patent, taken out in 1744 by this factory, stated that the earth used in the making of the porcelain was called "unacker" and came from the land of the Cherokee nation in Virginia. The second patent of 1749 does not mention "unacker," but the fact that there was this American connection in the beginning makes any collection of Bow porcelain in America seem appropriate.

The history of the Bow factory and its various periods has been discussed in considerable detail in the literature on the subject. A description of new types of porcelain, however, especially of those having marks, always furthers our knowledge of the history of porcelain, a difficult subject at best, so perhaps it is worth while to note the small collection in the Walters Art Gallery.

A vase with a hat-shaped cover and a short round form has a thick white glaze (Fig. 1). The decoration of birds and flowers is in the Oriental manner. Flowers on the cover are in relief after the fashion started at Meissen. The bird and flower decoration recalls similar patterns on a set of vases published by Egan Mew in his book, Old Bow Porcelain. The Walters vase and cover were made about 1756–1758 or shortly thereafter when Meissen workmen came to Bow from Chelsea owing to a partial closing of the latter factory. This event would explain why the flowers in relief recall the Chelsea rather than the Bow type of flowers. The bowl is beautifully proportioned, almost as fine as the Chinese porcelains to which the English turned for models in the eighteenth century.

**Fig. 1.—Bow vase and cover (ca., 1756–1762); no mark.**

**Fig. 2.—Bow ecuelle, plate, and cover (ca., 1757–1762); marks, anchor and dagger in red.**

An *ecuelle* with cover and plate has a thick glaze slightly tinged with blue (Fig. 2). The ground is dark blue with gilding, and reserved panels have bunches of fruit in typical Bow colors on a white ground. The anchor and dagger marks on the bottom of the bowl are in red. An excellent specimen of the practical porcelain made at the Bow factory, the painting of the fruit is especially fine, although the blue ground does not have the same depth as in contemporary Sèvres. The red anchor and dagger marks, according to Frank Hurlburt in his book entitled Bow Porcelain, would point to about 1757–1762 as the period when these three pieces were made, although a mug, similarly decorated, in the Schreiber collection at the Victoria and Albert Museum has been dated *circa* 1770. The fine strong colors and sturdy shape suited such *ecuelle* admirably to the English eighteenth-century interior.

A group representing Mars and Cupid, probably intended as a pendant for Bellona or some other emblematic figure, has a bluish glaze and is painted in natural colors, including the Bow puce, pink, and gold (Fig. 3). The anchor and dagger marks again are in red. Figures were apparently not made at Bow before 1757–1758, when the Meissen workmen came over from Chelsea, but were plentiful thereafter. The marks in red point to the period 1757–1765; and the elaborate roccoco scrolls of the base indicate the end of this period. The posture of Mars may be compared with the Bow Brittania. Emblems, such as Mars, Bellona, and Minerva, seem to have been fairly popular with the Bow patrons, a number of examples being in the various collections of old Bow.

**Fig. 3.—Mars and Cupid of Bow porcelain (ca., 1757–1765); marks, anchor and dagger in red.**

**Fig. 4.—Bow candelabra (ca., 1765–1770); marks, anchor and dagger in red.**

**Fig. 5.—Bow candelabra (ca., 1765–1770); marks, anchor and dagger in red.**

A pair of candelabra in the form of *boscages*, with a man seated beside a woman playing on a musical instrument, is again painted in natural colors (Figs. 4 and 5). The marks are also the anchor and dagger in red. At the back are the usual holes made for *ormulu* mounts that are typical only of the Bow factory. These elaborate *boscages* are generally considered to have been made *circa* 1770, recalling a Chelsea candelabra in the collection of P. Sidney and illustrated by William King in his book on English Porcelain Figures. The Bow marks in red on the Walters pair point to a

slightly earlier date. The figures doubtless are derived from Meissen models. The woman playing on a musical instrument first appeared at Bow as Columbine and later in other forms. Such elaborate groups as these candelabra were difficult to make and would have been done only for rich patrons. They carry the eighteenth-century passions for fragility almost to a *reductio ad absurdum*.

The same cupid in the group of Mars and Cupid is repeated in a slightly altered form in two candlesticks (Fig. 6). Cupid has a dog and is attempting to reach a bird in a *boscage*. The colors no doubt are what the eighteenth-century patrons considered to be natural. The usual anchor and dagger marks in red are used, and the small holes for *ormulu* mounts are at the back. The glaze is bluish, which, together with the marks in red and the elaborate base, indicates a date for these candlesticks of about 1760–1765.

This small group of Bow porcelain, although not representing all periods or the many types produced at the Bow factory, has the pleasing gaiety that one expects to find in eighteenth-century porcelains. Shown together, they indicate that the Bow factory at its best, for example, as in the covered vase, produced superb porcelains. The later candlesticks, however, although appealing, cannot compare as porcelain with the products of other European factories.

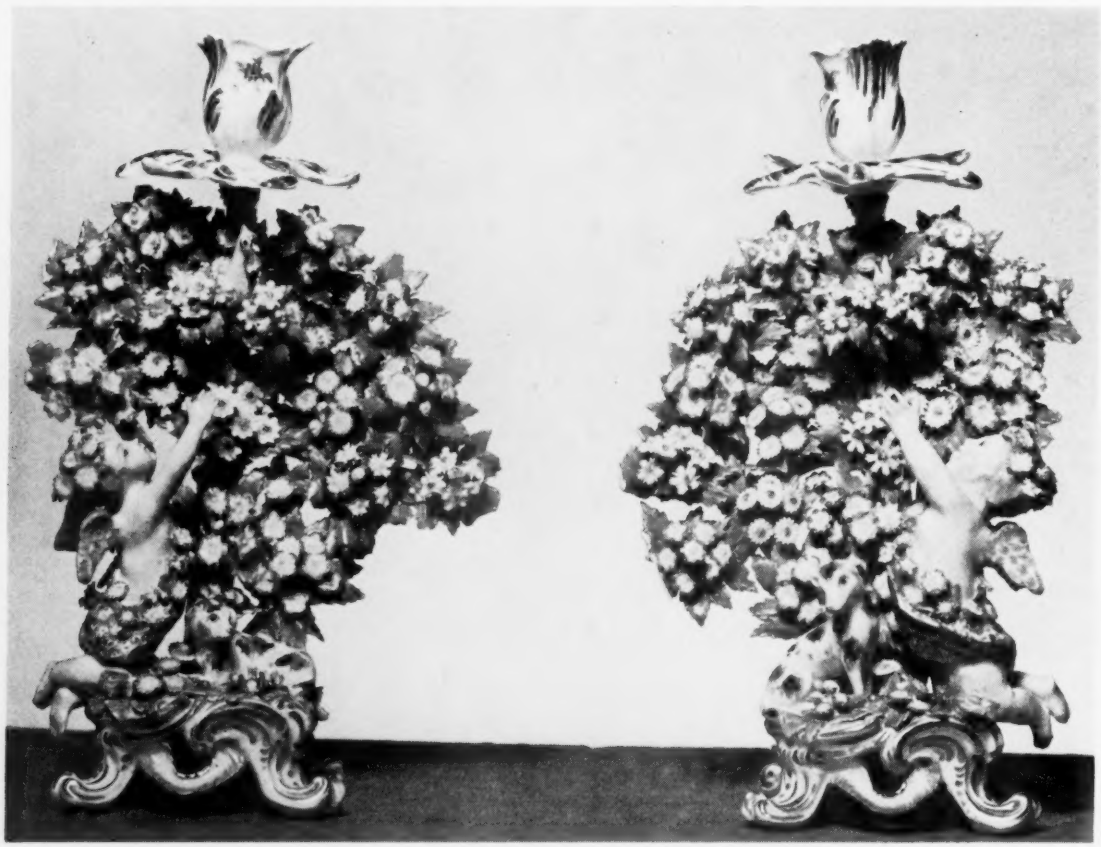


**Fig. 6.—Pair of Bow candlesticks (ca., 1765–1770); marks, anchor and dagger in red.**

# ACTIVITIES OF THE SOCIETY

## PROPOSED RULES OF THE ENAMEL DIVISION OF THE AMERICAN CERAMIC SOCIETY*

### Article ER I. Name

The official title of this Division shall be The Enamel Division of THE AMERICAN CERAMIC SOCIETY.

### Article ER II. Purpose

(1) It shall be the purpose of this Division to stimulate interest in the technical development of the porcelain enameled metals industry through the promulgation and discussion of technical and scientific papers relating to the materials and processes of manufacture and finished products of same; the promotion of scientific and industrial research in metal enameling; and the consideration of any scientific or industrial problems pertaining to porcelain enamel, except those relating to trade, prices, labor, tariff, and sales methods.

(2) This Division shall represent THE SOCIETY in matters pertaining to metal enameling when specifically authorized by the Board of Trustees.

### Article ER III. Membership

(1) The Enamel Division shall consist of those Fellows, Members, Corporation Members, and Life Members of these grades of THE AMERICAN CERAMIC SOCIETY in good standing whose major interest lies in the field covered by this Division and who have instructed the General Secretary of THE SOCIETY to so enroll them.

* Received July 2, 1940.

(2) The following grades of members enrolled in this Division shall be entitled to vote: Fellow, Member, Voter of Corporation Member, and Life Member of these grades.

(3) The following grades of members shall be entitled to hold office: Fellow, Member, and Life Member of either grade.

### Article ER IV. Government

(1) The affairs of this Division shall be directed by an Executive Committee consisting of the elected Chairman, Vice-Chairman, Secretary, two (2) Councillors, the Trustee, and the retiring Chairman of the Division.

(2) The term of office of the Chairman, Vice-Chairman, and Secretary shall be for one (1) year from the close of one Annual Meeting of THE SOCIETY to the close of the next succeeding Meeting, or until their respective successors have been elected and duly qualified. The term of office of the Councillors shall be two (2) years, one Councillor taking office at each Annual Meeting. The term of office of the Trustee shall be three (3) years, to wit: from the close of one Annual Meeting of THE SOCIETY to the close of the third following Meeting or until a successor has been elected and duly qualified.

(3) The Chairman shall not be eligible for immediate re-election.

(4) All vacancies occurring during the year shall be filled by appointment by the Executive Committee, unless otherwise specified in these Rules, and a person so appointed shall not forfeit the privilege of subsequent election to the same office.

### Article ER V. Meetings

(1) The Annual Business Meeting of this Division shall be held during the week of the Annual Meeting of THE SOCIETY.

(2) Ten per cent of the total voting membership of the Division shall constitute a quorum. The majority shall rule, except as otherwise specified in these Rules.

(3) Special business meetings of the Division may be called by the Chairman with the approval of the Executive Committee or by petition of ten (10) voting members upon thirty (30) days' notice.

### Article ER VI. Officers

(1) The Chairman shall have general supervision of the affairs of the Division. He shall preside at all meetings of the Division and shall be a member of the Committee on Sections and Divisions of THE SOCIETY. He shall appoint the Standing Committees and any special committees of the Division and also representatives of the Division to Standing or special committees of THE SOCIETY. The Chairman shall be an ex-officio member of all of the committees of the Division.

(2) The Vice-Chairman shall assist the Chairman and shall succeed to the powers and duties of the Chair in the event of the refusal or incapacity of the Chairman to act. He shall also act as Chairman of the Committee on Program and Papers.

(3) The Secretary shall keep the minutes of all business meetings and a full record of the correspondence of the Division. He shall, after leaving office, turn over all records of the Division to his successor.

(4) The Councillors shall counsel and assist the Chairman in the conduct and duties of his office and shall serve as members of the Executive Committee of the Division.

### Article ER VII. Nominations and Elections

(1) The Division representative elected to THE SOCIETY Nominating Committee A and to THE SOCIETY Nominating Committee B shall, together with a third member to be appointed by the Chairman of the Division with the approval of the Executive Committee, act as the Executive Nominating Committee of the Division. Said third member shall act as Chairman of the Executive Nominating Committee of the Division. Members of the Executive Nominating Committee, with the exception of the appointed member, shall be nominated and elected in the same manner and at the same time as the officers of the Division. All members of the Executive Nominating Committee shall have the same term of office as the officers of the Division.

(2) Additional nominations may be made by petition of ten (10) members in writing, providing the petition is accompanied by the nominee's acceptance in writing and is received by the Chairman of the Division at least ninety (90) days prior to the Annual Meeting of THE SOCIETY.

(3) It shall be the duty of the Division Nominating Committee to make annually one or more nominations each for Chairman, Vice-Chairman, Secretary, for one Councillor, and for each member to be elected to the Nominating Committee. The names of the nominees, together with their acceptances in writing, shall be certified to the Chairman at least one hundred and twenty (120) days prior to the Meeting of THE SOCIETY and shall be immediately published in the *Bulletin of The American Ceramic Society*.

(4) (*A*) The Nominating Committee shall triennially nominate two (2) or more candidates for office of Trustee Representative of this Division and shall certify their names, together with their acceptances in writing, to the Chairman of the Division at least one hundred and twenty (120) days prior to the Annual Meeting of THE SOCIETY, at which time the triennial term of the Trustee expires.

(*B*) The Chairman of the Division shall transmit nominations to the General Secretary of THE SOCIETY, who shall submit ballots by mail to the voting members of the Division at least sixty (60) days prior to the Annual Meeting of THE SOCIETY. Ballots shall bear the names of the nominees, instructions for voting, and the closing date of the voting. The marked ballots shall be returned to the Chairman in a plain envelope marked only with the words "Division Ballot." This envelope shall be enclosed in another envelope for mailing, upon the back of which the voter shall endorse his name. Only those ballots so returned prior to twelve o'clock noon of the nearest Tuesday thirty (30) days preceding the opening session of the Annual Meeting shall be counted.

(*C*) The Chairman shall have the ballots counted as soon as possible after the close of the voting and shall transmit the results of the election to the General Secretary of THE SOCIETY.

(5) In the event of the refusal or incapacity to act of the Trustee of this Division, a successor to fill the unexpired term shall be elected prior to the next Annual Meeting of THE SOCIETY, as provided in Article ER VII, Section (4) hereof.

### Article ER X. Relations with The Society

(1) As soon as possible after each Annual Meeting of THE SOCIETY, the Chairman of the Division shall fill all vacancies on the Standing Committees of the Division and of THE SOCIETY, as currently required by the By-Laws.

(2) The Chairman of the Division shall promptly appoint Division representatives to special committees of THE SOCIETY upon notification from the President of THE SOCIETY.

(3) The Division shall not expend funds of THE SOCIETY or incur indebtedness without the formal approval of the Board of Trustees.

(4) The Provisions of the Constitution, By-Laws, and Rules of THE SOCIETY shall govern the procedure of all Divisions, but no action or obligation of a Division shall be considered an action or obligation of THE SOCIETY. This By-Law shall be imprinted on any publication issued by a Division.

### Article ER XII. Committees

(1) (*A*) The Standing Committees of the Division shall be as follows:

(*a*) Rules
(*b*) Editorial
(*c*) Membership
(*d*) Standardization of Tests
(*e*) Program and Papers
(*f*) Research
(*h*) Data

(*B*) Committees shall serve during the term of office of the Chairman except as otherwise provided in these Rules,

and the Chairman of each Committee shall act as a Division representative on the respective general committees of THE SOCIETY.

(2) The Rules Committee shall consist of a Chairman and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. The Rules Committee Chairman shall function as Division representative on the Rules Committee of THE SOCIETY. It shall be the duties of this Committee to handle all problems relative to Division Rules. Any changes to the Rules recommended by the Committee shall be placed before the Division in the manner established by Article ER XV.

(3) The Editorial Committee shall consist of a Chairman and two (2) members, one (1) new member being appointed each year by the incoming Chairman of the Division for a term of three (3) years. The senior member shall be Chairman of the Committee in his final year. It shall be the duty of the Committee to act in cooperation with the editor of the publications of THE SOCIETY and the Committee on Publications of THE SOCIETY as the By-Laws and Rules of THE SOCIETY may currently specify.

(4) The Committee on Membership shall consist of a Chairman and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. The Chairman shall serve as a member of THE SOCIETY Committee on Membership. The duties of the Committee on Membership shall be to acquaint interested and qualified persons with the aims and interests of THE SOCIETY with the object of securing their cooperation as members of THE SOCIETY.

(5) The Committee on Standardization of Tests shall consist of a Chairman and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. It shall be the duties of the Committee to study and report to the Division at its annual meeting any improvements in methods of standardization of tests related to the enameling industry and to recommend to the Division such tests as in its wisdom it believes desirable to set up as standard tests of THE AMERICAN CERAMIC SOCIETY. The Chairman of the Committee shall serve as the Division representative on the Subcommittees C and D of the Committee on Standards of THE SOCIETY or shall, at his discretion, appoint a member of the Division Committee to serve on said Subcommittees in his stead.

(6) The Committee on Program and Papers shall consist of a Chairman, who shall be the Vice-Chairman of the Division, and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. It shall be the duties of the Committee to solicit papers and to plan the program for the Annual Meeting of the Division and to maintain the standard of the papers in accordance with Article ER XIII.

(7) The Committee on Research shall consist of a Chairman and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. It shall be the duties of this Committee to supervise and carry out research projects as ordered by vote of the Division, to survey and report on the desirability of initiating new research programs, and to carry out any function pertaining to research in the porcelain enamel industry as ordered by the Chairman and the Executive Committee of the Division. The Chairman shall serve as the Division representative on the Research Committee of THE SOCIETY.

(9) The Committee on Data shall consist of a Chairman and any additional members he may deem necessary, said members to be appointed by the Chairman subject to the approval of the Division Chairman. It shall be the duties of the Committee to collect and correlate desirable data at the request of the Division or of the Executive Committee. The Chairman shall serve as Division representative on the Data Committee of THE SOCIETY.

(12) The Chairman of the Division shall appoint such special committees as he may deem necessary The appointment of the Chairman of each special committee shall be subject to the approval of the Executive Committee of the Division.

### Article ER XIII. Presentation and Publication of Papers

(1) The time allowed for the presentation of any paper or discussion before any meeting of this Division may be limited at the discretion of the Chairman, unless otherwise ordered by vote of the members present.

(2) Recommended procedure for the presentation of papers of THE AMERICAN CERAMIC SOCIETY shall be followed.

(3) Papers dealing with materials or products designated only by trade names may not be presented before the Division unless the trade name is one in general use for a material of well-known composition or unless sufficient data are given to identify completely the material in a scientific manner.

(4) Abstracts of papers to be presented before any meeting of the Division shall be in the hands of the Chairman of the Program and Papers Committee not less than sixty (60) days prior to the meeting date, unless especially authorized by the Executive Committee of the Division.

(5) The Chairman of the Program and Papers Committee may, at his discretion, require the submission of two (2) copies of the final manuscripts of papers to be presented before any meeting of the Division not less than thirty (30) days prior to the meeting date.

(6) (*A*) In order to expedite the publication of papers, discussions, and committee reports of unusual value to the membership of the Division, the Executive Committee of the Division and the Editorial Committee of the Division shall, immediately following the Annual Meeting, prepare a suggested publication schedule of the papers, discussions, and committee reports presented at said Annual Meeting, listing same in their order of importance and submitting same to the Editor of publications of THE SOCIETY.

(*B*) The Executive Committee may further request immediate publication of papers, discussions, and committee reports in cases where inordinate delay in publication might react against the best interests of the Division.

### Article ER XV. Amendments

(1) Amendments to this Division's Rules may be proposed by the following methods:

(*A*) By petition of ten (10) voting members to the Division Chairman, providing such amendments be not inconsistent with the Constitution, By-Laws, or Rules of THE SOCIETY.

(*B*) By the acceptance of the Rules Committee and Executive Committee of proposed amendments submitted in writing by individuals to the Rules Committee.

(2) Proposed amendments to these Rules having met the above qualifications shall be presented to the Division in meeting assembled by the Chairman of the Rules Committee, together with his recommendations. Upon the affirmative vote of a majority of the members of the Division present, the proposed amendments shall be printed on ballots and sent out to the entire membership of the Division for final vote.

(3) An affirmative vote of not less than two-thirds ($^2/_3$) of the total votes cast within thirty (30) days after mailing shall be required for the adoption of the amendments to these Rules.

(4) Amendments shall be effective immediately upon the certification of the results of the balloting to the Chairman of the Division.

**Membership in**
**The American Ceramic Society**
**FOR CONTINUING EDUCATION IN CERAMICS**

# UP AND UP THE MEMBERSHIP COUNT GOES

## Vocational Security Is the Upward Motivating Force

Paid Membership Record

| Date of Record | Members Paid | | Deferred | Subscriptions | Monthly Sales | Total Circulation |
|---|---|---|---|---|---|---|
| | Personal | Corporation | | | | |
| December 22, 1937 | 1713 | 220 | 12 | 523 | 220 | 2688 |
| December 19, 1938 | 1815 | 222 | 26 | 589 | 220 | 2872 |
| December 19, 1939 | 1876 | 237 | 27 | 642 | 220 | 3002 |
| January 22, 1940 | 1930 | 244 | 23 | 656 | 220 | 3073 |
| February 20, 1940 | 1972 | 243 | 30 | 669 | 220 | 3134 |
| April 17, 1940 | 1724 | 241 | 30 | 522 | 220 | 2737 |
| May 21, 1940 | 1801 | 247 | 27 | 552 | 220 | 2847 |
| June 19, 1940 | 1839 | 251 | 28 | 556 | 220 | 2894 |
| July 18, 1940 | 1870 | 254 | 32 | 561 | 220 | 2937 |


## OFFICIAL AMERICAN CERAMIC SOCIETY EMBLEM

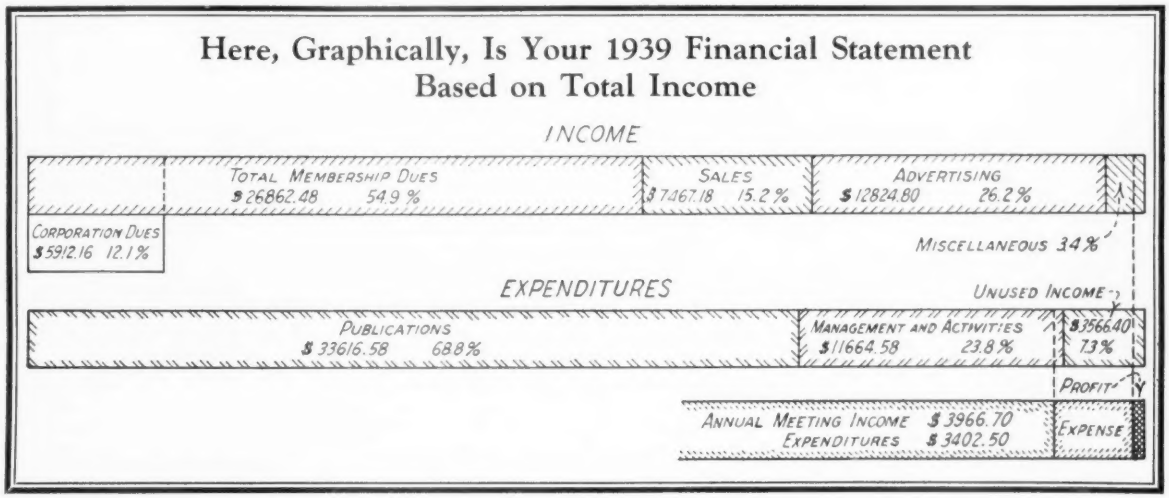
10 K. Solid Gold—$6.50
20-Year Gold Filled—$3.25

Order directly from

THE AMERICAN CERAMIC SOCIETY

2525 N. High St.,
Columbus, Ohio


## Here, Graphically, Is Your 1939 Financial Statement Based on Total Income




(1940)

# ROSTER OF PAID CORPORATION MEMBERS

**Abbé Engineering Co.**, New York, N. Y.
**Abingdon Sanitary Mfg. Co.**, Abingdon, Ill.
**A C Spark Plug Co.**, Flint, Mich.
**Akron Porcelain Co.**, Akron, Ohio
**American Gas Assn.**, New York, N. Y.
**American Lava Corp.**, Chattanooga, Tenn.
**American Nepheline Corp.**, Rochester, N. Y.
**American Potash & Chemical Corp.**, New York, N. Y.
**American Refractories Institute**, Pittsburgh, Pa.
**American Rolling Mill Co.**, Middletown, Ohio
**American Stove Company**, St. Louis, Mo.
**Amsler-Morton Co.**, Pittsburgh, Pa.
**Anchor Hocking Glass Corp.**, Lancaster, Ohio
**Arketex Ceramic Corp.**, Brazil, Ind.
**Armstrong Cork Co.**, Lancaster, Pa.
**Atlantic Terra Cotta Co.**, Perth Amboy, N. J.

**Babcock & Wilcox Co.**, New York, N. Y.
**Ball Brothers Co.**, Muncie, Ind.
**Baltimore Enamel & Novelty Co.**, Baltimore, Md.
**Bardin, Paul, e Hijos**, Soc. Anon. Com., Buenos Aires, Argentina, South America
**Bausch & Lomb Optical Co.**, Rochester, N. Y.
**Belden Brick Co.**, Canton, Ohio
**Blue Ridge Glass Corp.**, Kingsport, Tenn.
**Blythe Colour Works, Ltd.**, Cresswell, Stoke-on-Trent, England
**Bonnot Company**, Canton, Ohio
**Braun Corp.**, Los Angeles, Calif.
**Brockway Glass Company, Inc.**, Brockway, Pa.
**Buck Glass Company**, Baltimore, Md.
**Buffalo Pottery**, Buffalo, N. Y.

**California Art Products, Inc.**, Los Angeles, Calif.
**Camp Brothers Company**, Mogadore, Ohio
**Canadian General Electric Co., Ltd.**, Peterborough, Ontario, Canada
**Canton Stamping & Enameling Co.**, Canton, Ohio
**Carborundum Company**, Niagara Falls, N. Y.
**Carnegie-Illinois Steel Corp.**, Pittsburgh, Pa.
**Carr-Lowrey Glass Co.**, Baltimore, Md.
**Celo Mines, Inc.**, Burnsville, N. C.
**Central Silica Company**, Zanesville, Ohio
**Ceramic Color & Chemical Mfg. Co.**, New Brighton, Pa.
**Certain-Teed Products Corp.**, Buffalo, N. Y.
**Champion Spark Plug Co.**, Detroit, Mich.
**Chattanooga Glass Co.**, Chattanooga, Tenn.
**Chicago Hardware Foundry Co.**, North Chicago, Ill.
**Chicago Pottery Co.**, Chicago, Ill.
**Chicago Vitreous Enamel Product Co.**, Cicero, Ill.
**Clark, N., & Sons**, San Francisco, Calif.
**Colonial Insulator Co.**, Akron, Ohio
**Commercial Decal Products, Inc.**, East Liverpool, Ohio
**Consolidated Feldspar Corp.**, Trenton, N. J.
**Coors Porcelain Company**, Golden, Colo.
**Corhart Refractories Co., Inc.**, Louisville, Ky.
**Corning Glass Works**, Corning, N. Y.
**Crane Enamelware Company**, Chattanooga, Tenn.
**Cronin China Co.**, Minerva, Ohio
**Crooksville China Co.**, Crooksville, Ohio
**Crossley Machine Co.**, Trenton, N. J.
**Crossman Company**, South Amboy, N. J.
**Crown Potteries Co.**, Evansville, Ind.

**DeVilbiss Co.**, Toledo, Ohio
**Dixon, Joseph, Crucible Co.**, Jersey City, N. J.
**Drakenfeld, B. F., & Co.**, New York, N. Y.
**Du Pont de Nemours, E. I., & Co.**, R. & H. Chemicals Dept., Wilmington, Del.

**Edgar Plastic Kaolin Co.**, Metuchen, N. J.
**Electro Refractories & Alloys Corp.**, Buffalo, N. Y.
**Empire Sheet & Tin Plate Co.**, Mansfield, Ohio

**Engelhard, Charles, Inc.**, Newark, N. J.
**English China Clays Sales Corp.**, New York, N. Y.
**Eureka Flint & Spar Co.**, Trenton, N. J.
**Exolon Company**, Blasdell, N. Y.

**Fairfacts Company, Inc.**, Trenton, N. J.
**Federal Seaboard Terra Cotta Corp.**, Perth Amboy, N. J.
**Ferro Enamel Corp.**, Cleveland, Ohio
**Findlay Clay Products Co.**, Washington, Pa.
**Foote Mineral Co.**, Philadelphia, Pa.
**Fords Porcelain Works**, Perth Amboy, N. J.
**Fostoria Glass Co.**, Moundsville, W. Va.
**Frazier-Simplex, Inc.**, Washington, Pa.

**Garco Products, Inc.**, Butler, Pa.
**Gaynor Glass Works**, Salem, N. J.
**General Ceramics Co.**, New York, N. Y.
**General Electric Co.**, Lamp Dept., Pitney Glass Works, Nela Park, Cleveland, Ohio
**Gillinder Brothers, Inc.**, Port Jervis, N. Y.
**Gladding, McBean, & Co.**, Lincoln, Placer County, Calif.
**Gleason-Tiebout Glass Co.**, Maspeth, N. Y.
**Glenboig Union Fireclay Co., Ltd.**, Glenboig, Scotland
**Great Lakes Foundry Sand Co.**, Detroit, Mich.
**Great Lakes Steel Corp.**, Detroit, Mich.
**Green, A. P., Fire Brick Co.**, Mexico, Mo.

**Haeger Potteries, Inc.**, Dundee, Ill.
**Hall China Company**, East Liverpool, Ohio
**Hancock Brick & Tile Co.**, Findlay, Ohio
**Hanley Company**, Summerville, Pa.
**Hanovia Chemical & Mfg. Co.**, Newark, N. J.
**Hardinge Company, Inc.**, York, Pa.
**Harshaw Chemical Co.**, Cleveland, Ohio
**Hartford-Empire Co.**, Hartford, Conn.
**Haws Refractories Company**, Johnstown, Pa.
**Hazel-Atlas Glass Co.**, Wheeling, W. Va.
**Hommel, O., Co.**, Pittsburgh, Pa.
**Houze, L. J., Convex Glass Co.**, Point Marion, Pa.
**Humphryes Manufacturing Co.**, Mansfield, Ohio
**Hygrade Sylvania Corp.**, Emporium, Pa.

**Illinois Clay Products Co.**, Joliet, Ill.
**Industrial Ceramic Products, Inc.**, Columbus, Ohio
**Ingram-Richardson Mfg. Company of Indiana, Inc.**, Frankfort, Ind.
**International Clay Machinery Co.**, Dayton, Ohio
**International Smelting & Refining Co.**, Akron, Ohio
**Irish Glass Bottle Co., Ltd.**, Dublin, Ireland
**Ironton Fire Brick Co.**, Columbia, S. C.
**Isolantite, Incorporated**, Belleville, N. J.
**Iyo Toki Kaisha, Ltd.**, Kobe, Japan

**Kaolin, Incorporated**, Spruce Pine, N. C.
**Kentucky Clay Mining Co.**, Mayfield, Ky.
**Kentucky-Tennessee Clay Co.**, Mayfield, Ky.
**Knowles, Edwin M., China Co.**, Newell, W. Va.
**Kohler Company**, Kohler, Wis.
**Koppers Company**, Pittsburgh, Pa.
**Kraftile Company**, Niles, Calif.

**Laclede-Christy Clay Products Co.**, St. Louis, Mo.
**Lancaster Iron Works**, Lancaster, Pa.
**Lapp Insulator Co., Inc.**, Le Roy, N. Y.
**Laughlin, Homer, China Co.**, Newell, W. Va.
**Lava Crucible Co. of Pittsburgh**, Pittsburgh, Pa.
**Lee Clay Products Company**, Clearfield, Ky.
**Libbey Glass Company**, Toledo, Ohio
**Libbey-Owens-Ford Glass Co.**, Toledo, Ohio
**Liberty Glass Co.**, Sapulpa, Okla.
**Lindemann, A. J., & Hoverson Co.**, Milwaukee, Wis.
**Locke Insulator Corp.**, Baltimore, Md.

**London Brick Co., Ltd.**, London, England
**Louthan Manufacturing Co.**, East Liverpool, Ohio
**Lynch Corporation**, Anderson, Ind.
**Lynch, A. J., & Co.**, Los Angeles, Calif.

**Mansfield Sanitary Pottery, Inc.**, Perrysville, Ohio
**Mapleton Clay Products Company**, Canton, Ohio
**Maryland Glass Corp.**, Baltimore, Md.
**Mason City Brick & Tile Co.**, Mason City, Iowa
**Maxson, Elwyn L.**, Los Angeles, Calif.
**McHose, L. H., Inc.**, Perth Amboy, N. J.
**McKee, Arthur G., & Co.**, Cleveland, Ohio
**Metal & Thermit Corp.**, New York, N. Y.
**Metro Glass Bottle Co.**, Jersey City, N. J.
**Mississippi Glass Co.**, New York, N. Y.
**Mitchell Clay Mfg. Co.**, St. Louis, Mo.
**Moore Enameling & Mfg. Co.**, West Lafayette, Ohio
**Moore & Munger**, New York, N. Y.
**Mosaic Tile Company**, Zanesville, Ohio
**Mount Clemens Pottery Co.**, Mount Clemens, Mich.

**National Engineering Co.**, Chicago, Ill.
**National Fireproofing Corp.**, Pittsburgh, Pa.
**National Gypsum Co.**, Clarence Center, N. Y.
**National Industrial Sand Assn.**, Washington, D. C.
**National Lead Co.**, Brooklyn, N. Y.
**National Lime and Stone Co.**, Findlay, Ohio
**New Castle Refractories Co.**, New Castle, Pa.
**New Jersey Porcelain Co.**, Trenton, N. J.
**New Jersey Pulverizing Co.**, New York, N. Y.
**Nippon Gaishi Kabushiki Kaisha**, Nagoya, Japan
**Nippon Toki Kaisha, Ltd.**, Nagoya, Japan
**North American Refractories Co.**, Cleveland, Ohio
**North Carolina Feldspar Corp.**, Erwin, Tenn.
**Norton Company**, Worcester, Mass.

**Ohio Insulator Company Div., Ohio Brass Co.**, Barberton, Ohio
**Old Hickory Clay Co.**, Paducah, Ky.
**Olean Tile Co.**, Olean, N. Y.
**Onondaga Pottery Co.**, Syracuse, N. Y.
**Orefraction, Inc.**, Pittsburgh, Pa.
**Orton, Edward, Jr., Ceramic Foundation**, Columbus, Ohio
**Owens-Illinois Glass Co.**, Alton, Ill.
**Owens-Illinois Pacific Coast Co.**, San Francisco, Calif.

**Pacific Clay Products**, Los Angeles, Calif.
**Pacific Coast Borax Co.**, New York, N. Y.
**Pacific Tile & Porcelain Co.**, Los Angeles, Calif.
**Paper Makers Importing Co., Inc.**, Easton, Pa.
**Pass & Seymour, Inc.**, Solvay, N. Y.
**Pennsylvania Pulverizing Co.**, Lewistown, Pa.
**Pennsylvania Salt Mfg. Co.**, Philadelphia, Pa.
**Pfaudler Company**, Rochester, N. Y.
**Pittsburgh Plate Glass Co.**, Creighton, Pa.
**Porcelain Enamel & Mfg. Co.**, Baltimore, Md.
**Porcelain Products, Inc.**, Findlay, Ohio
**Portsmouth Clay Products Co.**, Portsmouth, Ohio
**Potters Supply Co.**, East Liverpool, Ohio
**Precision Grinding Wheel Co.**, Philadelphia, Pa.

**Quigley Company, Inc.**, New York, N. Y.

**Ramtite Co.**, Chicago, Ill.
**Ransome Concrete Machinery Co.**, Dunellen, N. J.
**Remmey, Richard C., Son Co.**, Philadelphia, Pa.
**Republic Steel Corp.**, Youngstown, Ohio
**Riddell, W. A., Co.**, Bucyrus, Ohio
**Roseville Pottery Co.**, Zanesville, Ohio
**Ross-Tacony Crucible Co.**, Philadelphia, Pa.
**Rundle Manufacturing Co.**, Milwaukee, Wis.
**Rustless Iron Co., Ltd.**, Keighley, England

**Safety Grinding Wheel & Machine Co.**, Springfield, Ohio
**San Miguel Brewery, Inc.**, Manila, P. I.
**F. E. Schundler & Co., Inc.**, Joliet, Ill.
**Seagram, Joseph E., & Sons, Inc.**, Louisville, Ky.
**Shenango Pottery Company**, New Castle, Pa.
**Simonds Worden White Co.**, Dayton, Ohio
**Smith & Stone, Ltd.**, Georgetown, Ontario, Canada
**Solvay Process Company**, Syracuse, N. Y.
**Southern California Gas Co.**, Los Angeles, Calif.
**Spinks, H. C., Clay Co.**, Newport, Ky.
**Square D Company**, Detroit, Mich.
**Standard Brick and Tile Corp.**, Evansville, Ind.
**Standard Lime & Stone Co.**, Baltimore, Md.
**Standard Sanitary Mfg. Co.**, Louisville, Ky.
**Star Porcelain Co.**, Trenton, N. J.
**Stark Brick Co.**, Canton, Ohio
**Stauffer Chemical Co., Inc.**, New York, N. Y.
**Steele, J. C., & Sons**, Statesville, N. C.
**Sterling Grinding Wheel Co.**, Tiffin, Ohio
**Structural Clay Products Institute**, Washington, D. C.
**Sur Enamel & Stamping Works, Ltd.**, Calcutta, India
**Swindell Brothers**, Baltimore, Md.
**Swindell-Dressler Corp.**, Pittsburgh, Pa.

**Taylor, Smith, & Taylor Co.**, Chester, W. Va.
**Texas Mining & Smelting Co.**, Laredo, Texas
**Titanium Alloy Mfg. Co.**, Niagara Falls, N. Y.
**Toyo Toki Kwaisha**, Kokura City, Japan
**Trenton Potteries**, Trenton, N. J.
**Twyfords, Limited**, Stoke-on-Trent, England
**Tyler, W. S., Company**, Cleveland, Ohio

**Union Electrical Porcelain Works, Inc.**, Trenton, N. J.
**Union Française des Produits Refractaires**, Paris, France
**United Clay Mines Corp.**, Trenton, N. J.
**United Glass Bottle Mfrs., Ltd.**, London, England
**United States Gypsum Co.**, Chicago, Ill.
**Universal Clay Products Co.**, Sandusky, Ohio
**Universal Dental Co.**, Philadelphia, Pa.
**Universal Sanitary Mfg. Co.**, New Castle, Pa.

**Vanderbilt, R. T., Company**, New York, N. Y.
**Vereeniging Brick & Tile Co., Ltd.**, Vereeniging, Transvaal, South Africa
**Verreries Souchon Neuvesel**, Lyon, France
**Vesuvius Crucible Co.**, Swissvale, Pa.
**Victor Insulators, Inc.**, Victor, N. Y.
**Vitrefrax Corporation**, Los Angeles, Calif.
**Vitreous Steel Products Co.**, Cleveland, Ohio
**Vitro Manufacturing Co.**, Pittsburgh, Pa.

**Wallace China Co., Ltd.**, Huntington Park, Calif.
**Waltham Grinding Wheel Co.**, Waltham, Mass.
**Washington Porcelain Co.**, Washington, N. J.
**Wayne Laboratories**, Waynesboro, Pa.
**Western Brick Co.**, Danville, Ill.
**Western Electric Co.**, Chicago, Ill.
**Westinghouse Electric & Mfg. Co.**, Derry, Pa.
**West Virginia Brick Co.**, Charleston, W. Va.
**Wheeling Steel Corp.**, Yorkville, Ohio
**Wisconsin Porcelain Co.**, Sun Prairie, Wis.

**Youngstown Arc Engraving Co.**, Youngstown, Ohio


# CORPORATION MEMBERSHIPS ARE PROFITABLE INVESTMENTS

## NEW MEMBERS FOR JULY

**Corporation**

GLENBOIG UNION FIRECLAY CO., LTD., Alexander McKendrick (voter), The Laboratory, Star Works, Glenboig, Lanarkshire, Scotland.

**Personal**

AGNEW, G. D., Universal Potteries, Inc., Cambridge, Ohio; vice-president and general manager.

BRADY, HUGH J., Jeannette Glass Co., Jeannette, Pa.; vice-president.

CARLSON, CHARLES W., 229 Sunnland Ave., Pittsburgh, Pa.; president, United States Glass Co.

COUCH, EVERETT G., JR., Corhart Refractories Co., 16th and Lee Sts., Louisville, Ky.; assistant sales manager.

FIX, FRANK A., 305 Pearl St., Lancaster, Pa.; sales and service, Lancaster Iron Works, Inc.

FREY, WILLIAM J., II, 303 McGraw Ave., Grafton, W. Va.; ceramic engineer and decal foreman, Carr China Co.

GERBER, MAX, Kokomo Sanitary Pottery Co., Kokomo, Ind.; president.

GILL, JOHN H., Gill Clay Pot Co., Muncie, Ind.; secretary and general manager (formerly in name of Charles O. Grafton, personal member).

HERBERT, JOHN S., 174 Third Ave., North, Nashville, Tenn.; mechanical engineer, W. G. Bush & Co.

KAME, KEIZABURO, Nippon Glass Co., Hodogaya-ku, Yokohama, Japan; superintendent.

KOLOVSKY, LEON R., 8200 S. Ellis Ave., Chicago, Ill.; chief chemist, Weber-Costello Co.

MACNAMARA, F. L., Ball Brothers Co., Muncie, Ind.; manager of laboratory.

MARTIN, JAMES K., 1068 Helen Ave., Lancaster, Pa.; assistant manager, Brick Machine Div., Lancaster Iron Works, Inc.

MILLER, ROGER O., 112 Newell Ave., Trenton, N. J.; manager, Economy Pottery Co.

OWEN, FREDERICK E., Electrical Refractories Co., East Palestine, Ohio; president.

PROBST, LOUIS, National Sanitary Co., Salem, Ohio; vice-president.

RAIT, J. R., William Jessop & Sons, Ltd., Brightside Works, Sheffield, England.

ROSS, MYRON A., 33 N. LaSalle St., Chicago, Ill.; president, Pressed Prism Plate Glass Co.

*SHERWIN, RONALD W., H. & R. Johnson, Ltd., Tunstall, Staffs, England.

STAFFORD, EDWARD F., 396 W. Indiana Ave., Sebring, Ohio; plant superintendent and ceramic engineer, Royal China, Inc.

WEINSTEIN, ALEX, Ednal Company, 95 Madison Ave., New York, N. Y.

**Student**

*New York State College of Ceramics:* RAYMOND R. ZURER.

---

* Indicates former member of The Society rejoining.

# NECROLOGY

## M. H. BEEKMAN

M. H. Beekman, manager of the Hotpoint Company, Kitchen Sanitation Division of Chicago, Ill., succumbed on June 11 to a heart attack in his hotel room in Cincinnati, Ohio, where he was attending a convention. His home was in Wheaton, Ill.

Mr. Beekman was born in Columbia, N. Y., September 26, 1886, and spent his boyhood there and in Red Bank, N. J. Following his graduation from Rutgers University, in 1909, he joined the Crocker-Wheeler Manufacturing Company at Ampere, N. J., and later went with the Hall Switch and Signal Company of New York.

M. H. Beekman

In 1921 he joined the Edison General Electric Appliance Company of Chicago (the Hotpoint Company) as assistant to the Chicago district manager.

## JOHN M. MALLORY

John Milton Mallory, prominent industrialist and for nearly half a century identified with the Central of Georgia Railway and affiliates, died in Savannah, Ga., on June 4, 1940, after an illness of about two weeks.

Mr. Mallory was born in Oktibbeha County, Mississippi, on June 1, 1873, the son of Wiley Brooks and Mary A. Morehead Mallory. He attended school in his native city and completed his education in Henderson, Tenn., and at West Tennessee Christian College. He began his railroad career with the Illinois Central Railroad at Natchez, Miss., later being transferred to Jackson.

In 1894, Mr. Mallory became associated with the Central of Georgia Railway as ticket agent at Griffin, Ga. He was stationed, during a period of ten years, at Griffin, Athens, Madison, and Macon; in 1904, he went to Savannah, where he was advanced to the position of industrial agent in 1906 and general industrial agent in 1922.

Mr. Mallory retired on June 1, 1938, and since that time had devoted his interests largely to the development of Georgia's resources, a subject in which he had been a pioneer and moving spirit for many years.

He was recognized as one of Georgia's outstanding citizens, both from a practical and a cultural standpoint. Few men have done as much for the conservation and development of the State's resources. He was recognized in railway and industrial circles as an outstanding factor in the progress of the Southeast, having played a prominent part in the upbuilding of the textile industry in this territory and, more recently, in the development of the ceramic industry.

Mr. Mallory assisted in the establishment of the Ceramic Department at the Georgia School of Technology at Atlanta and in the Herty Foundation Laboratory at Savannah.

It was during his travels as a railroad man that Mr. Mallory became interested in the resources of the State and endeavored to develop such native material as clay. He was vitally interested in the forests of the State and did extensive research in this field. He engaged in a study of the history and development of clay and ceramics and had a profound knowledge and appreciation of this subject.

Mr. Mallory wrote extensively on the subject of the clay, his findings being of invaluable importance to such records. He made a hard fight for the use of native clays instead of others imported into Georgia from abroad. As a result of these activities, he was appointed by Governor Russell to the State Board of Forestry and Geological Development and was a Regent of the Alabama State Museum of Natural History.

**J. M. Mallory**

Mr. Mallory was also a member of the State Planning Board and served as a director of the Savannah Chamber of Commerce.

He had been a member of The American Ceramic Society since 1918.

He was also a member of the American Chemical Society, a Fellow of the American Geographical Society, and a vice-president of the Society for Georgia Archeology. He was prominent in Masonic circles, holding high degrees in the York and Scottish Rite, including membership in the Yaarah Temple, Ancient Arabic Order of Nobles of the Mystic Shrine. He was an associate member of both the Southern and of the Georgia Association of Commercial Secretaries and held membership in the American Railway Development Association.

Mr. Mallory is survived by his widow, one son, and two grandsons.

(1940)

## THE INSTITUTE OF CERAMIC ENGINEERS

**Executive Committee**

*President:* H. G. WOLFRAM, Porcelain Enamel & Mfg. Co., Baltimore, Md.

*Vice-President:* E. H. FRITZ, Westinghouse Electric & Mfg. Co., Derry, Pa.

*Secretary:* H. M. KRANER, Bethlehem Steel Co., Bethlehem, Pa.

*Past-President:* J. L. CARRUTHERS, Ohio State Univ., Columbus, Ohio.

*Trustee Representative:* R. E. BIRCH, Harbison-Walker Refractories Co., Pittsburgh, Pa.

**Book List**

Several reading lists of books on general engineering subjects have been discussed in *The Bulletin* (April, 1939, p. 150). In view of the feeling that a more specific list was needed for ceramic engineers, a special Book List Committee was appointed last year by A. F. Greaves-Walker. This Committee, of whom A. I. Andrews is Chairman, has prepared the following book list. This may be considered as a suggested reading and reference list for young ceramic engineers.

1. Ceramics. Pennsylvania State College, Mineral Industries Extension Div., 1938.
2. Ceramics by E. P. McNamara. Pennsylvania State College, 1939.
3. Burning Clay Wares by Ellis Lovejoy. T. A. Randall & Co., 1930.
4. Clays by Heinrich Ries. John Wiley & Sons, Inc., 1927.
5. Refractories by F. H. Norton. McGraw-Hill Book Co., Inc., 1931.
6. Chemistry of Cement and Concrete by F. M. Lea and C. H. Desch. Edward Arnold & Co., London, 1935.
7. Porcelain Enameling by J. E. Hansen. Enamelist Publishing Co., 1937.
8. Industrial Minerals and Rocks. American Institute of Mining and Metallurgical Engineers, 1937.
9. Chemical Engineers' Handbook by J. H. Perry. McGraw-Hill Book Co., 1934.
10. Handbook of Chemistry and Physics by C. D. Hodgman. Chemical Rubber Publishing Co., 1934.
11. Emailfabrikation by Ludwig Stuckert. Julius Springer, Berlin, 1929.
12. Enamels by L. R. Mernagh. Charles Griffin & Co., Ltd., London, 1928.
13. Modern Glass Practice by S. R. Scholes. Industrial Publications, Inc., 1935.
14. Enamels by A. I. Andrews. Twin City Printing Co., 1935.
15. Properties of Silica by R. B. Sosman. Chemical Catalogue Co., Inc., 1927.
16. Ceramics (Clay Technology) by Hewitt Wilson. McGraw-Hill Book Co., 1927.
17. Marketing Burned-Clay Products by A. Hamilton Chute. Ohio State University, 1939.
18. Principles of Phase Diagrams by J. S. Marsh. McGraw-Hill Book Co., 1935.
19. Refractory Materials by A. B. Searle. Charles Griffin & Co., Ltd., 1924.
20. Factory Design and Equipment and Manufacture of Clay Wares by T. W. Garve. T. A. Randall & Co., Inc., 1929.
21. Fundamentals and Economies in the Clay Industries by Ellis Lovejoy. Randall Publishing Co., 1935.
22. Properties of Glass by G. W. Morey. Reinhold Publishing Corp., 1938.
23. Minerals Yearbook. U. S. Dept. of the Interior, Bureau of Mines, U. S. Govt. Printing Office, 1939.
24. Clays and Some Other Ceramic Materials by C. W. Parmelee. Edwards Bros., Ann Arbor, Mich.

25. Manufacture of Optical Glass and of Optical Systems by F. E. Wright. Ordnance Dept. Document No. 2037, May, 1921, Govt. Printing Office, Washington, D. C.

26. Textbook of Glass Technology by F. W. Hodkin and A. Cousen. D. Van Nostrand Co., New York, 1925.

27. Defects in Glass (Anon.). Glass Publications, Ltd., London, W. C. 2, 1927.

28. Refractory Blocks for Glass Tank Furnaces by J. H. Partridge. Society of Glass Technology, Darnall Road, Sheffield, England, 1935.

**Indiana Recognizes Ceramic Engineers**

The Indiana State Board of Registration has recognized ceramic engineering and has given ceramic engineers a separate classification. This action on the part of the State of Indiana gives added impetus to the progress of the ceramic engineering profession in the United States.

# NOTES FOR CERAMISTS

## DEGREES IN CERAMICS AT RUTGERS UNIVERSITY FOR 1940

*Doctor of Philosophy in Ceramics:* KENNETH T. GREENE, LOUISE HARROP, and JAMES M. HUMPHRYS.

*Master of Science in Ceramics:* PHILIP D. BALCOM and MARVIN O. LEWIS.

*Bachelor of Science in Ceramics:* ROBERT B. BRAID, ROBERT R. BROOKS, CLARENCE H. HILL, JR., CHARLES R. LANDBACK, JR., JAMES H. MILLER, CHARLES W. PIEZ, JR., FRED J. POTTER, 3RD, JOHN T. SMITH, and OTTO R. STACH.

## UNION INTERNATIONALE DE CHIMIE PUBLICATIONS

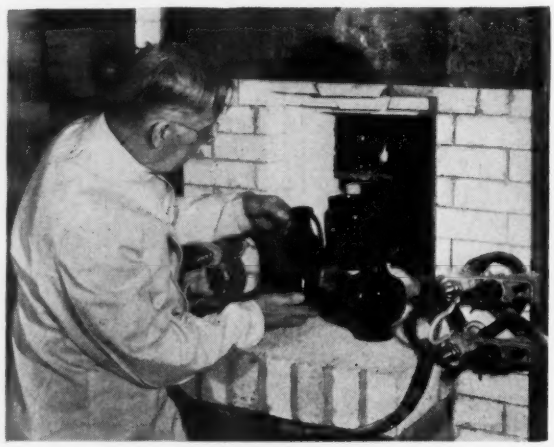
The Union Internationale de Chimie of Paris, France, has recently published the following reports: (1) International Table of Atomic Weights, (2) International Table of Stable Isotopes, and (3) Rules for Naming Inorganic Compounds. These reports were sent to The Society on June 3, 1940.

## CERAMIC ART PROVES VALUABLE IN OCCUPATIONAL THERAPY

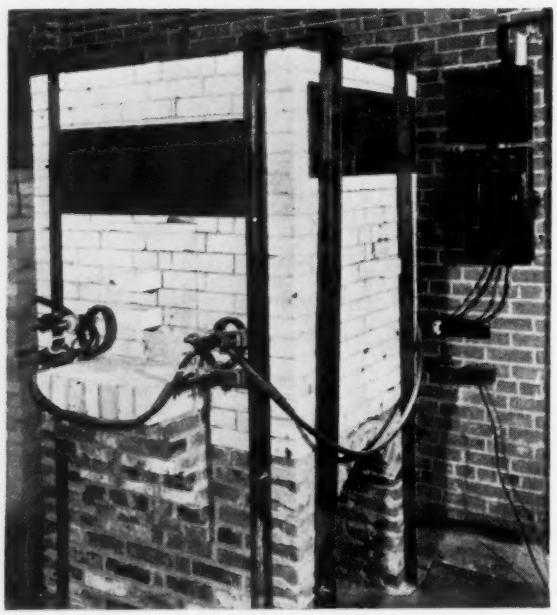
Electric heat has entered into a new role as a therapeutic assistant at the Phipps Clinic, in Baltimore, Md., where a 16-kw. electric furnace has been installed recently to fire pottery produced by the patients at this institution.

The ceramic shop is a branch of the Department of Occupational Therapy where, according to William H. Russell, who developed it, "any craft, art, or vocation that can qualify as a satisfying hobby, qualifies for a place on the roster."

**Leighton Williams, instructor in ceramics, Department of Occupational Therapy, at Phipps Clinic. On the shelf is a small electric kiln used for test purposes and for firing miniature pieces.**



**W. H. Russell, instructor in Occupational Therapy at Phipps Clinic, removing a charge of completed pieces from the electric furnace. Some of the work is of such high quality and so beautifully wrought that it is a credit to artists in the craft.**



**The electric furnace, equipped with 16 kw. in Globar heaters, installed at Phipps Clinic for pottery firing.**

## BIBLIOGRAPHIES ON GLASS MANUFACTURE

Two new bibliographies on glass manufacture are ready for distribution. These review the literature for the years 1938 and 1939. A bibliography covering the year 1937 was also recently announced.

The bibliographies consist of one volume for each year, of about 250 pages each, mimeographed, size $8^1/_2$ by 11 inches, and bound in printed cardboard covers. They are the result of cooperative work with the Work Projects Administration.

The subjects covered include (1) raw materials, (2) refractories, (3) furnaces and accessories, (4) fuels, (5) the batch, (6) manufacture, (7) constitution, (8) physical and chemical testing, (9) books, etc. An author and a subject index are included, and there are many United States and foreign patents under the pertinent classification and noted in the index.

This work brings together in one volume, for each year, an index pertaining particularly to glass manufacture, giving not only the title and reference but usually a further brief statement of the contents of articles published during the year.

For manufacturers and others interested in glassmaking, these volumes offer an opportunity to secure a reference index to most of the recent publications in that field at a nominal cost. The very limited edition is priced at two dollars per volume to partly cover the cost of materials used. Copies may be obtained from John D. Beatty, Bureau of Recommendations, Carnegie Institute of Technology, Pittsburgh, Pa.

### Foreword to Bibliography

In outlining the variety of researches to be undertaken by the Work Projects Administration, it was decided that surveys of a scientific, social, political, and economic nature were especially desirable. This bibliography, the third on this subject, contains information on literature related to glass manufacture during 1939. As in previous volumes, workers have examined all available literature, domestic and foreign, pertaining to glass manufacture and its technology and have made extracts of selected articles, giving information to indicate their character and contents. Articles in foreign language periodicals have been translated and similarly abstracted. References show in which publication the article may be found and, in many cases, where abstracts or condensations have been published; the names of those periodicals are also given. Many notices of domestic and foreign patents have been included.

This work has been sponsored by the Carnegie Institute of Technology under the direction of Harry S. Hower, Head of the Department of Physics. Through the cooperation of the Institute, this index has been made available to the public. It should be useful to anyone desiring to review the data pertaining to glass manufacture published in 1939.

The libraries of the Mellon Institute of Industrial Research, the United States Bureau of Mines, and the Carnegie Library of Pittsburgh have given workers the free use of their files. We are indebted to members of their staffs for their cooperation.

—John M. Henry, *District Manager, Allegheny County District, Work Projects Administration*

## FORTY-THIRD ANNUAL MEETING OF A.S.T.M.

The Forty-Third annual meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 24 to 28, 1940, was marked with a record-breaking attendance.

### 1941 Meeting in Chicago

The 1941 meeting of the A.S.T.M. will be held in Chicago, Ill., June 23 to 27, at the Palmer House, at which time the Sixth Exhibit of Testing Apparatus and Related Equipment will also take place.

## PAPERS BY H. W. GILLETT AND D. J. CAVANAUGH

Two articles of especial interest to readers of *The Bulletin* appear in *Foote-Prints* (Vol. 13, No. 1), the house publication of the Foote Mineral Company, Philadelphia, Pa.

H. W. Gillett discusses "Some Features of Ductile Zirconium and Titanium" and D. J. Cavanaugh writes of "Brick Manganese in Buff-Firing Clays." The article by Dr. Gillett deals with research in connection with ductile zirconium, a new metal. He discusses the possible industrial applications of this metal, one of the most interesting of which is its peculiar quality of adherence to glass. When glass is scratched with a zirconium pencil, a brilliant metallic streak appears, which may be buffed to a high brilliance. This does not tarnish in air nor will it wash off with soap and water. "One can imagine an artist with a zirconium or titanium pencil, conveniently mounted in something like a dentist's drill, sketching on glass as readily as he does with pencil on paper."

A free copy of *Foote-Prints* may be obtained by writing to the Foote Mineral Company, 1609 Summer St., Philadelphia, Pa.

## A LABORATORY COURSE IN REFRACTORIES*

By Nelson W. Taylor

### (1) Introduction

Instruction in refractories at The Pennsylvania State College is given in thirty lectures and 45 to 50 hours of laboratory work. Ten experiments have been designed to show the principles underlying the behavior of refractory materials as related to physical texture and chemical properties. These experiments are discussed. A separate course, Ceramic Petrography, dealing in part with refractory materials, is given simultaneously so that the student is made familiar with both the macro- and microcharacteristics of refractories under a variety of conditions.

Refractories is a subject which cannot be presented satisfactorily without laboratory experiments because the unique properties of refractory materials at high temperatures must be seen to be appreciated. A longer time than 45 or 50 hours would be desirable for such work but cannot be assigned on account of a crowded undergraduate curriculum. Opportunities for research are available, and frequently senior or graduate theses are undertaken on refractories problems of special interest. The laboratories are well equipped for this work.

To present the subject adequately in the available time, it is necessary to stick rather closely to fundamentals. This is done in the belief that manufacturing details of equipment and processes will be readily grasped by the student when he sees them in the commercial plant, provided he already understands the aim and purpose of the process and the nature of the change which it is desired to effect in the raw materials by the operation.

### (2) Laboratory Experiments

In choosing the laboratory experiments out of a very large number of possibilities, several factors have to be borne in mind.

* Presented at the Forty-Second Annual Meeting, American Ceramic Society, Toronto, Canada, April 10, 1940 (Refractories Division). Received April 10, 1940.

(1) The procedure must lend itself to the normal three-hour period. In exceptional cases, it may require four hours of continuous attention by the student, but furnace firing or other operations of longer times than this are impractical because they do not fit well into the usual student schedule.

(2) The apparatus must not be too complicated or too expensive because the student may get lost in detail and fail to see the main purpose of the experiment and because of limited budgets.

(3) Experiments of a quantitative or semiquantitative character are preferable to those of a qualitative or descriptive type because the former lend themselves much more readily to the detection of errors of technique or of observation. They demand higher standards of the students and, if performed satisfactorily by them so that the results check known data, they develop confidence in the underlying principles and in the student's own skills. There are certain experiments, however, where the main value lies in the qualitative results and in their interpretation.

(4) The range of refractories topics is so wide and the materials which come under this heading so numerous that the ten experiments which at present can be performed in the 50 hours available must be chosen so as to avoid unnecessary duplication of subject matter. For this reason, it is unwise to measure one physical or chemical property on a variety of materials, although this might be the chief interest of a specialist who already had a general background of knowledge of the field of refractories.

(5) If it is possible to demonstrate or teach certain test methods, more or less standard, such as those of A.S.T.M. Committee C-8, this is desirable, bearing in mind, however, the limitations of the three-hour laboratory period and the importance of teaching principles.

The present list of experiments is the result of study of this problem during the past seven years. Every experiment has undergone some changes during this period. Many experiments have been tried and abandoned for some of the reasons described. The reader may notice the absence of certain experiments in which he is particularly interested. Work on plastic pressing of stiff-mud bodies, for example, is not peculiar to refractories alone and is covered in another course. Quantitative chemical analysis is also taught in another course given by the Chemistry Department. Work on petrography of refractory materials is covered in a separate course which runs concurrently. Petrographic studies are made on refractories after various heat treatments, on refractories showing slag attack, on certain raw materials, etc. The two courses in conjunction give the student a pretty good insight into the fundamental physical and chemical properties of refractories and the principles governing their behavior. It is not claimed that the present collection is perfect, although some of our graduates who have gone into the refractories field state that this training has qualified them very well for their work in the steel and glass industries and in the manufacture of refractories products.

#### (3) Lecture Topics

The lectures cover such topics as (1) industrial applications of refractories, a general introduction; (2) characteristics of the several refractory materials, classified into one-component systems, e.g., $SiO_2$; two-component systems, e.g., $MgO$–$Fe_2O_3$; poly-component systems, e.g., fire clays; (3) important physical properties, such as thermal expansion, porosity, spalling resistance, thermal conductivity, load-bearing characteristics, etc.; (4) unit operations in manufacture, such as beneficiation of raw materials, sizing of particles, slip casting, drying, firing, etc.; (5) physicochemical processes in manufacture or in service, such as polymorphic changes, solid-phase reactions, solid solution, catalytic processes, solid-liquid reactions, and surface tension and viscosity phenomena.

The A.S.T.M. C-8 "Standards on Refractory Materials" is used as well as several reference works and a large number of scientific and technical journal articles. The Department is fortunate in having a file of 15,000 cards on refractories subjects, each carrying an abstract of a published article supplied by L. Litinsky of Milan, Italy.

#### (4) Outline of Laboratory Experiments

*(1) Structural Changes in Silica Due to Heat Treatment*

*Object:* To show (*a*) sluggish character of silica inversions in absence of any catalyst; (*b*) catalytic effect of small amounts of $Na_2O$; (*c*) technique for measurement of true density of powders.

*Material:* Potter's flint.

*Apparatus:* Furnace, pycnometer, vacuum pump, analytical balance.

*Report:* Give stable temperature range for polymorphic forms of silica; mechanism of the catalysis; quantitative density data; sketch of apparatus.

*(2) Dial Measurements of Thermal Expansion*

*Object:* (*a*) To demonstrate effect of heat treatment of silica brick on its thermal expansion and to show the critical temperature range in heating or cooling silica; (*b*) to show a technique for making thermal-expansion measurements.

*Materials:* Silica brick, poorly fired and well fired.

*Apparatus:* Dial-type gauge, fused silica tubing.

*Report:* Show expansion curves of samples and of silica polymorphs; explain the results obtained; sketch apparatus.

*(3) Packing of Different-Sized Particles*

*Object:* (*a*) To show principles of packing of irregular grains of two sizes and application to production of refractory bodies.

*Materials:* Crushed firebrick grog.

*Apparatus:* Cylindrical container vibrated on Ro-Tap machine.

*Report:* Show plot of packing efficiency in terms of weight percentage of fines; explain curve.

*(4) Preparation of Refractory Bodies by Slip Casting and by Dust-Pressing*

*Object:* (*a*) To demonstrate two methods of preparing refractory bodies with optimum packing of grog particles; (*b*) to demonstrate effect of grog variation; (*c*) to give practice in kiln firing and recording of thermal history.

*Materials:* Grog, ball clay, and deflocculant.

*Apparatus:* Molds, screw press, kiln, thermocouple, optical pyrometer, and pyrometric cones; compression machine for strength tests.

*Report:* Show amounts of the materials used; give firing schedules and results of strength test.

(5) *Effective or Apparent Porosity by Russell Volumeter Method, or Porosity and Apparent Specific Gravity by A.S.T.M. Procedure*

*Object:* (*a*) To demonstrate certain methods for getting volume of connected pores, using water, acetylene tetrachloride, or other suitable liquids; (*b*) to obtain data on samples prepared and fired in experiments (3) and (4).

*Materials:* Samples from preceding experiments.

*Apparatus:* Russell volumeter or standard A.S.T.M. equipment.

*Report:* Give all data and discuss relative results.

(6) *Permeability of a Refractory Body*

*Object:* (*a*) To demonstrate directional properties of refractory brick due to their mode of manufacture; (*b*) to show simple method to estimate tendency of brick to gas leakage or slag penetration; (*c*) to show that permeability is not related to porosity.

*Materials:* Commercial brands of refractories.

*Apparatus:* Sample holder, pressure gauge, stopwatch, and gas meter.

*Report:* Give all data; show calculations; sketch apparatus.

(7) *Iron Compounds as Possible Catalysts for Carbon Deposition*

*Object:* (*a*) To determine which compounds $Fe_2O_3$, $Fe_3O_4$, or $Fe_2SiO_4$ is most effective in promoting carbon deposition from CO; (*b*) to show contrast between equilibrium effects and rate effects as to the reaction $2CO \rightleftarrows C + CO_2$; (*c*) to emphasize importance of catalytic processes in reactions involving refractories.

*Materials:* $Fe_2O_3$, $Fe_3O_4$, $Fe_2SiO_4$, laboratory gas (28% CO).

*Apparatus:* Pyrex-brand glass tube in muffle furnace at 500°C.

*Report:* Discuss results; sketch apparatus; give equilibrium constants at several temperatures for CO dissociation.

(8) *Melting Range of Refractory Substances Determined Without Contamination*

*Object:* (*a*) To demonstrate simple method for getting fusion temperature of slags or other corrosive materials.

*Materials:* Open-hearth slag or coal ash.

*Apparatus:* Radiation furnace; optical pyrometer.

*Report:* Give all data and other pertinent observations.

(9) *Reactions Between Different Refractories*

*Object:* (*a*) To demonstrate that refractories may form eutectics and thereby destroy one another at sufficiently high temperatures; (*b*) to demonstrate simple carbon-arc radiation furnace for easy production of high temperatures; (*c*) to show value of microscopic examination of refractory products.

*Material:* Refractories of fire clay, silica, magnesite, forsterite, and high alumina.

*Apparatus:* Small carbon-arc furnace, 110 v. 15 a.

*Report:* Describe observations, macroscopic and microscopic; give interpretations; sketch apparatus.

(10) *Chemical Corrosion of Refractories; "Phase Equilibria"*

*Object:* (*a*) To show use of systematic cone-fusion tests in study of melting behavior of mixtures of refractory substances; (*b*) to demonstrate effects of viscosity; (*c*) to show influence of furnace atmosphere; (*d*) to show relation of cone-fusion data to true equilibrium data.

*Material:* Mixtures of $Fe_2O_3$ and $SiO_2$.

*Apparatus:* Gas-fired muffle furnace, optical pyrometer.

*Report:* Show equilibrium as well as cone fusion diagrams with data plotted; discuss various factors thoroughly.

(11) *Spalling, Load-Bearing Ability, and After-Shrinkage:* Covered by demonstrations; later to be elaborated into formal experiments.

(12) *Classification of Topics Illustrated by Foregoing Experiments*

*I. Unit Operations:* Sizing of particles; packing of particles; slip casting; dry pressing; drying; and firing.

*II. Physicochemical Processes:* (1) Change of solid phase, polymorphism, by heat treatment (structure changes in silica); (2) catalysis (*a*) of phase change ($SiO_2$), (*b*) of gas decomposition (CO) by iron oxides; (3) solid-liquid "equilibria," (*a*) melting range of slags, without contamination, (*b*) eutectic formation (reactions between refractories), (*c*) cone fusion studies (equilibrium diagrams modified by viscosity effects).

*III. Measurement of Physical Properties of Refractory Materials:* Thermal expansion; porosity, permeability; true specific gravity; liquidus temperature; crushing strength; microscopic features.

In developing this course, an effort has been made to avoid extreme practicality on the one hand or too theoretical a presentation of subject matter on the other. The purpose of ceramic education of college grade is not to teach apprentices but to educate students in the fundamentals upon which they may establish their careers.

Department of Ceramics
The Pennsylvania State College
State College, Pennsylvania

## *He Succeeds Who Determines So to Do*

**It Is Only by Communication with Others That Knowledge Is Acquired; Membership in The American Ceramic Society Is Opportunity for This Achievement**

# THE CERAMIC EXTENSION PROGRAM OF THE PENNSYLVANIA STATE COLLEGE*

By Edward P. McNamara

Abstract

There is a demand throughout the ceramic industries for courses of less than college grade to train men for positions requiring skill and responsibility. This demand is being met in Pennsylvania by the Ceramic Extension Course of the Division of Mineral Industries Extension. The course consists of a three-year curriculum offering third-year options in clay products and whiteware, refractories, glass, and enamels. A printed and bound textbook is prepared for each year of the course. Classes are held in the plant or in the city in which the plant is located, and the teachers are experienced ceramic engineers. Teaching funds are made available by the state and federal governments. The history, present status, and future plans of the course are presented.

## I. Introduction

The Pennsylvania State College is a pioneer in the field of industrial educational extension work. As early as 1893, extension instruction was given to men engaged in the mining industry. Courses were held in the mining communities of the State by members of the staff of the Mining Department. This work continued until 1931, when the Division of Mineral Industries Extension of the School of Mineral Industries was organized. Inasmuch as the School of Mineral Industries was reorganized and so named in 1929 to provide instruction and research facilities for all of the mineral industries, both extractive and primary processing, it was logical to provide extension instruction to parallel the resident instruction in all of the mineral industries fields.

Before 1931, extension instruction was given only in mining, but since that time courses in petroleum and natural gas, metallurgy, and ceramics have been added. All of the work of the Mineral Industries Extension Division is conducted according to one general plan. Fundamental three-year courses of study for each of the industries served by the School are given as part-time evening courses to the employed men in the mineral industries when requested by companies or groups of employees. The classes are held in the plants or in the local schools in the communities in which the men are working. The educational level of the work is less than college grade but, in general, it is above the grade of high-school work. It is prepared in such a way as to be most suitable for men who have had some years of experience in their particular industry.

## II. Federal Vocational Acts

In 1917, the federal Smith-Hughes Bill was passed, which provides an annual appropriation by the federal government to the states for the promotion of vocational education. In 1936, another federal bill, the George-Deen Act, was passed, which provides additional monies for the states to supplement the Smith-Hughes funds. Both of these acts apportion the appropriation among the several states according to their urban and rural populations. Each state must match the federal grant from combined state and local funds. The actual administration of the funds is the function of the individual state, and the methods of disbursing the funds vary from state to state.

## III. Pennsylvania Vocational Acts

In Pennsylvania, the State Department of Public Instruction makes these funds available to the local school districts throughout the State. The present State vocational acts provide that any group of fifteen or more persons may request a vocational evening class from their local school district, and that district is obligated to provide the course. The State acts also provide that monies expended by local school districts for the salaries of vocational teachers shall be reimbursed from the State and federal funds for the complete amount spent until 1942. The local schools must have teachers certified by the State Department of Public Instruction and pay their salaries during the year. The course of study must also be approved by the State Department.

## IV. Methods of Providing Extension Classes

Since 1918, mining classes have been conducted under this plan by the College and, since 1931, most of the courses offered by the Mineral Industries Extension Division have been carried on under a plan in which the Extension Division cooperates with the State Department of Public Instruction, the local school district, and the local industry in offering the course. The College furnishes the text material and supervises the teaching of the subject matter of the course. The State Department of Public Instruction supervises the classes with respect to federal and State regulations and reimburses the local school district; the latter provides a meeting room and employs the teacher during the school term on a part-time basis. Since 1931, the State Department of Public Instruction has approved the courses of study offered by this Division and has approved the general idea of the three-year curriculum.

In certain localities, where the local school districts will not provide the necessary teaching funds or where an industry desires to sponsor the classes privately, an arrangement may be made whereby the instructor is selected by the College and is paid by the company or in some instances is paid a pro-rated fee by the students. For a class of fifteen persons, a fee of $15.00 to $20.00 per year is adequate to cover all instructional costs.

## V. Mineral Industries Extension

The Mineral Industries Extension Division was organized to meet a demand for local instruction by the various branches of the mineral industries. It has always been the policy of this Division to give a broad basic training rather than short courses in highly specialized

* Presented at the Forty-Second Meeting, The American Ceramic Society, Toronto, Canada, April 9, 1940 (Art Division). Received May 20, 1940.

work. Short, specialized courses are in great demand and would be more popular perhaps than a longer course, but it is felt that the basic courses should come first if any lasting benefit is to be derived from such a program of education.

#### (1) Three-Year Curriculum

The basic three-year curriculum in each of the mineral industries branches was an early development of the Division. This plan has been generally successful in all of the courses, although the study of each industry has individual peculiarities. The three-year curriculum provides time for one year of basic fundamentals, followed by two years of more specialized work. Each year of the curriculum is planned to consume a minimum of 120 class hours of instruction, which is a course of approved length. The entire curriculum involves a minimum of 360 hours of instruction. Classes usually meet two nights a week, two hours each night for thirty weeks, during the winter months. The College grants a certificate at the successful completion of each year of the course and a diploma at the completion of the three years of the curriculum.

#### (2) Use of Printed Textbooks

Another development, which has greatly aided the entire Mineral Industries extension program and which is unique, is the compiling of textbooks by the members of the extension staff. Each Division of the extension work is in charge of a supervisor of extension who, in addition to planning the courses and supervising the teaching work in the local centers, prepares text material which is published by the Extension Division in the form of printed and bound textbooks. Each book contains all of the text material necessary for one year of study in the course. The books are sold to extension students for the actual cost of printing. The cost of preparation is borne by the College as a service to the people and industries of the State. The prices of the books vary from $2.50 to $3.50 per copy and represent the entire cost of the course to the student as far as the College is concerned. The cost of organization and supervision is also furnished as a free service by the College.

The printed textbooks have probably contributed more to the success of the entire program than any other single factor. They have made it possible to cover much more material in a given time than could be accomplished if the instructor had to present all of the material by the lecture method. They have served to standardize the work so that the same general material is covered in all classes and have enabled the use of experienced engineers as instructors by relieving them of the basic planning of the course and the extensive preparation of lecture material. They have provided comprehensive text material at a minimum cost to students, and when each student finishes the three-year course, he has a small reference library on the general processes of his industry, which he understands quite thoroughly.

## VI. Ceramic Extension

#### (1) Early Classes

The program of extension work in ceramics was offered on an organized basis on October 1, 1936. Before that time, some work in ceramics had been offered under the Director of the Division. In the fall of 1933, the first ceramic extension class center was organized at Woodland, Pa., for men in the refractories industry of that locality. Eleven men were enrolled in this class, and the same eleven men went completely through the course and received their extension diplomas in the spring of 1936. Mimeographed text material was prepared for this class by members of the resident staff in ceramics. The text material for this course was prepared entirely from the standpoint of clay refractories.

In the fall of 1936, another class was organized at Clarion, Pa., for the glass-container industry located there. It at once became apparent that the clay course used at Woodland was not satisfactory for an extension course for glass men.

#### (2) Content of Course in Ceramics

When it was announced, in 1936, that ceramic extension work would be offered, requests for class centers were received from all branches of the ceramic industry. It was the original intent of the Division to offer one three-year course which would apply to all branches of the industry, including glass and enamels as well as clay products and refractories. When ceramics was placed on an organized basis, it at once became apparent that such a single three-year course would not be satisfactory and that a separate course would be necessary for each of the different ceramic industries.

When a study was made of the material which must be presented in a three-year curriculum, it was found that enough of the material was common to all branches of ceramics to provide two of the three years as a general ceramic course and all of the specialized material would be concentrated in the third year. This led to the plan under which all ceramic text material has been prepared to date and under which the classes in all branches of ceramics are organized and operated.

#### (3) Optional Courses

The five optional courses available to workers in the various ceramic industries are refractories, clay products, whiteware, glass, and enamels. For the first two years, all classes use the extension textbooks, Ceramics, Volume I (General Preparatory Course), and Ceramics, Volume II.[1] Classes in clay products and whiteware use Ceramics, Volume III, Clay Products and Whiteware, for the third year. A third-year text is now being prepared for use in the refractories option. Classes in glass use Modern Glass Practice by S. R. Scholes, and classes in enamels use Enamels by A. I. Andrews for the third-year text.

Although the various classes use the same textbooks, and the course is taught around the text, the material is presented in a specialized way as it applies to the industry and plant in which the men are working. The instructors are experienced engineers from the same industry and are often from the same plant as the students, and they supplement the text material by practical examples and discussions.

---

[1] Complete reviews of the extension textbooks were published in *Bull. Amer. Ceram. Soc.*, **19** [3] 114 (1940).

## VII. Considerations in Conducting an Industrial Course in Ceramics

### (1) Complexity of Field

In planning the entire three-year program for ceramics, many difficulties were encountered, some of which have not yet been removed. Because of the complexity of the field covered by the term "ceramics," there is almost no feeling of unity except by the most progressive technical men. The management and plant employees do not realize any common interest between such industries as whiteware, brick manufacturing, glass, refractories, and enameling. When persons working in these industries think of educational courses they think in terms of short, highly specialized courses of study which apply only to the operations with which they are familiar and which do not include any basic fundamentals or theoretical material. The value of such courses is questionable unless the students are well informed in the general theories underlying the various operations.

### (2) Presentation of Material

It is well recognized that any industrial vocational course of this kind should begin with practical discussions with which the students are familiar. The presentation of theory should be tied in directly with familiar operations, and the more advanced subjects should be presented toward the end of the course. To do this would require many separate courses and if textbooks were to be provided the cost would be high. To accomplish the purpose in the ceramic field, it has been necessary to reverse the logical order of presentation of material. The course begins with basic mathematics, chemistry, and physics in the first year and continues with such general subjects as raw materials, pyrometry, fuels, combustion, and silicate chemistry in the second year. The actual processes with which the students are working are not studied until the third year. This method of presentation discourages all but the most ambitious men, who realize that the general training will be of more value to them. As a whole, a course of this type appeals only to ambitious persons who are desirous of obtaining better positions or of making their present situations more secure. For persons of this caliber, the course has proved satisfactory.

### (3) Enrollments and Completions

In the fall of 1937, eight new class centers were opened in central and western Pennsylvania. Since that time, four additional centers have been started. Current enrollment is approximately two hundred with an average of twenty persons per class.

The general method of organization has been to start a group of fifteen to thirty men and to carry them through the three-year course. The records of completions in the ceramic courses have compared favorably with those in the other mineral industries courses. For the year 1937–1938, the completions averaged about 65%, and for the year 1938–1939, they were 80%. It is indicated that approximately 50% of the original enrollment in the classes will receive diplomas for the successful completion of the three-year course. Some classes have almost perfect completion records. There is a wide variation, influenced chiefly by the attitude of the plant management.

Where the management gives active support to the program, the results achieved are gratifying. In other instances, only the most outstanding men attend successfully. It is all too common for the plant management to induce men to take the course and then to forget them. If the workers are willing to give their own time to pursue outside study, the management should take this into account and assist them in coordinating the classroom studies with their jobs in the plant.

The most successful groups have been those in which the students have been carefully selected by the management from those employees who show the most promise of developing into valuable key men and also from those foremen and others in responsible positions who can benefit most by such a course of study.

### (4) Educational Level and Age of Students

The average educational level and the average age of enrollees in the classes have remained remarkably constant over a period of several years. The average educational level for ceramic students has been third-year high school and the average age twenty-nine years. These averages correspond almost exactly to the statistics from the metallurgy and petroleum and natural gas students, but they are somewhat higher than the averages of the mining students. It is interesting to note that it was possible to predict these figures before the ceramic course was offered. In planning the work for the first year of the course, the average educational level was taken into account. The average age of twenty-nine years indicates that the majority of the men have had about ten years of working experience, and they are usually established permanently with the companies for which they work.

There is a wide variation in the individual ages and previous education of the extension students. The ages run from eighteen to fifty years and previous education from sixth grade to men with advanced college degrees. This situation makes it rather difficult in teaching the course, because some of the work is too advanced for some and rather elementary for others. After the first year, however, little difficulty is encountered.

### (5) Supervision and Supplementary Instruction

In addition to the regular teaching by the instructors, frequent supervisory visits are made from the College. Supplementary instructional material is brought to the classes in this way, and members of the resident teaching staff in ceramics occasionally give special talks to the classes. The Division has moving-picture sound projectors and an extensive film library of instructional science films as well as films of industrial operations.

## VIII. Conclusion

### (1) Ultimate Object

The ultimate desire in offering ceramic extension education is to provide the ceramic industries of Pennsylvania and their employees with courses of study in the various phases of ceramics.

The present three-year course is not the answer to all of the employee educational problems of the various ceramic industries. Similar three-year courses, however, have proved so successful in the other mineral industries where the problems are similar that it holds promise of

being a successful start in the whole process of building a highly trained body of operating employees.

#### (2) Future Development of Program

The experience gained during the past four years has indicated some of the following possible developments in this field of educational work:

(1) To offer shorter introductory courses to give employees an introduction to the general technological fields of their particular industry and to show how the technology of the entire field of ceramics is interrelated.

(2) To strengthen the present three-year course by textbook revision and by obtaining closer cooperation with industrial management.

(3) To provide follow-up courses for those who complete the basic three-year course. At the completion of the present course, the men just begin to realize how much they do not know and they wish to continue their education.

(4) To provide traveling teachers operating from the College who are especially trained in the various major fields of ceramics and who are fitted to conduct classes of this type. In some instances, classes cannot be organized because qualified teachers are not available.

(5) To provide some means of offering the same work to groups too small to support an organized class and also to isolated individuals. Correspondence courses are now being prepared and it may be possible to organize supervised correspondence study groups.

(6) To coordinate this type of semitechnical education with other kinds of employee education, such as personnel training, to provide ceramic plants with a well-trained operating personnel.

(7) To provide specialized courses of varying length to meet rapid technological changes in the industry.

#### (3) Conclusion

Although at the present time this type of technical vocational training is paying dividends to those companies which are actively engaged in educating their employees, this course may eventually develop into a well-rounded program of ceramic education that will give the various ceramic industries of Pennsylvania the best informed and most efficient personnel in the country.

#### Acknowledgment

The author gratefully acknowledges the constructive criticism of H. B. Northrup, Director of Mineral Industries Extension, The Pennsylvania State College.

Division of Mineral Industries Extension
The Pennsylvania State College
State College, Pennsylvania

## ELECTION OF OFFICERS AT NORTON COMPANY

The Norton Company Board of Directors has announced the election of Harry K. Clark as vice-president and general manager and Andrew B. Holmstrom as vice-president and works manager.

#### H. K. Clark

Mr. Clark has been with the Company for twenty-five years, having held the positions of salesman, district manager of the Chicago territory, sales manager of the Abrasive Division, general sales manager, director of the Company, and vice-president. He is executive officer in charge of Norton Company of Canada, Ltd., a director of Behr-Manning Corporation of Troy, N. Y., and a director of Australian Abrasives (Pty.), Ltd., Sydney, Australia. He is also an active member of the Grinding Wheel Manufacturers' Association, president of the American Supply and Machinery Manufacturers' Association, and holds membership in the American Society of Sales Executives.

#### A. B. Holmstrom

Mr. Holmstrom has been connected with the Company for twenty years, during which time he has had considerable experience as an engineer and in plant management. After five years in the Norton plants engineering department (1920 to 1925), he was appointed to the office of superintendent of sewers of the city of Worcester at a time when the city was installing a large Imhoff trickling-filter sewage purification plant. When the plant was completed he returned to the Norton Company, later going to England as resident engineer of the Norton Grinding Wheel Company, Ltd., at Welwyn Garden City.

Two years later, he returned to the Worcester plant, but, in 1934, he went back to England as general manager of the British plant, returning again to the United States in 1939 to assume the responsibility of works manager of the Abrasive Division. Mr. Holmstrom is a member of the American Society of Civil Engineers.

#### Norton Training for Young Men

In connection with the change, President A. C. Higgins and Treasurer G. N. Jeppson issued the following joint statement:

"We believe that the interests of the Company will be best served by the election to the positions of general manager and works manager of men younger in years but long in training and service of the Company. We realize that younger men must ultimately succeed us and we personally desire to be relieved from the duties and responsibilities of the above offices at this time.

"It has been a time-honored policy of the Company to train young men in the standards and traditions of our Company and in the technique of our business, so that we could promote from among our own people men whom we believe capable of carrying on those standards and traditions which were passed on to us by our fathers.

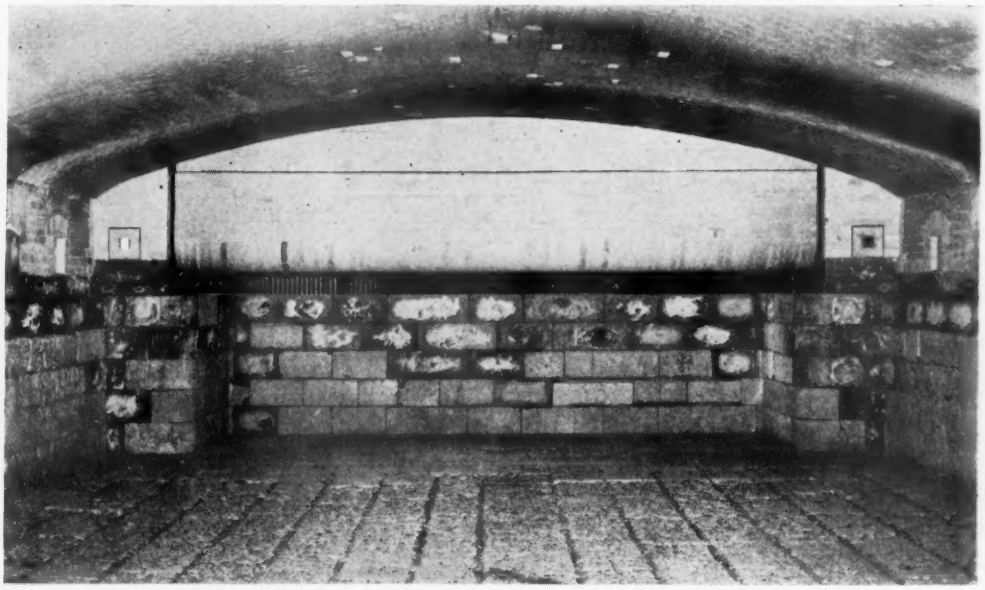
Mr. Jeppson, treasurer and vice-president of the Company, became a member of The American Ceramic Society in 1906 and was elected to Fellowship in 1936. The Norton Company has held a Corporation Membership in this Society since 1917.

## AUTUMN DIVISION MEETINGS

| | | |
|---|---|---|
| **Glass** | **Hotel Hershey, Hershey, Pa.** | **September 6–7** |
| **Materials and Equipment and Whitewares** | **Summit Hotel, Uniontown, Pa.** | **September 13–14** |
| **Refractories** | **Summit Hotel, Uniontown, Pa.** | **September 6–7** |

# OFFICIAL PERSONNEL OF DIVISIONS, 1940–1941

| | Art | Enamel | Glass | Materials and Equipment | Refractories | Structural Clay Products | White Wares |
|---|---|---|---|---|---|---|---|
| Trustee | L. E. Barringer | J. E. Hansen | D. E. Sharp | H. B. DuBois | J. D. Sullivan | A. F. Greaves-Walker | E. H. Fritz |
| Chairman | H. S. Nash | J. D. Tetrick | W. R. Lester | B. T. Bonnot | J. B. Austin | H. Z. Schofield | Harry Thiemecke |
| Vice-Chairman | K. E. Smith | | A. K. Lyle | W. H. Emerson | Gilbert Soler | J. H. Isenhour | |
| 2nd Vice-Chairman | | | W. C. Taylor | | | | |
| Secretary | C. C. Engle | D G Bennett | S. R. Scholes | S. S. Cole | R. S. Bradley | L. R. Whitaker | R. Russell, Jr. |
| Society Nominations A..... | M. M. French | B. T. Sweely | F. C. Flint | W. R. Malkin | G. A. Bole | R. L. Stone | L. E. Thiess |
| Society Nominations B..... | C. C. Engle | R. R. Danielson | W. M. Clark | H. R. Straight | S. M. Phelps | T. W. Garve | D. C. Zimmer |
| Division Nominations | Ruth Canfield<br>A. A. Ayars | H. G. Wolfram | A. N. Finn | | | | |
| Papers and Program | W. A. Weldon<br>Carlton Atherton<br>J. P. Thorley | R. L. Fellows | A. K. Lyle<br>W. C. Taylor | S. S. Cole<br>J. R. Kauffman<br>R. Buchholz | C. L. Thompson<br>W. R. McLain<br>G. S. Diamond | H. D. Foster<br>F. E. Lobaugh<br>J. E. Rankin | F. C. Henderson<br>Howard Failmezger<br>C. G. Harman |
| Membership | H. E. Marley<br>H. H. Sanders | Karl Kautz | C. B. Delgado | J. T. Robson | C. A. Freeman | J. H. Stewart | G. J. Bair |
| Standards | A. E. Baggs | F. W. C. Hutchison | G. W. Morey | W. H. Vaughan | P. S. Dear | H. C. Plummer | J. H. Koenig |
| Research | H. F. Bopp | R. J. Whitesell | N. W. Taylor | J. F. McMahon | D. W. Ross | Frederick Heath, Jr. | J. R. Beam |
| Data | Marion Fosdick<br>P. E. Cox | P. C. McCollom | A. E. Badger | R. G. O'Meara | P. G. Herold | H. G. Schurecht | G. A. Loomis |
| Rules | Theodore Lenchner | G. H. Spencer-Strong | A. N. Finn | J. E. Eagle | R. B. Sosman | G. H. Duncombe, Jr. | K. E. Stettinius |
| Councillors | C. M. Harder<br>A. E. Baggs | W. H. Pfeiffer<br>R. D. Cooke | L. C. Roche<br>F. C. Flint | V. V. Kelsey<br>F. E. Finch | | C. R. Austin<br>T. W. Garve | F. P. Hall<br>Karl Schwartzwalder |
| Exhibitions | Ruth Randall | *Bibliography*<br>J. E. Rosenberg | R. M. Curts | | | | |
| Industrial Management | F. H. Rhead | | | | G. B. Remmey | | |



*What you are looking for is here—*

# A SUSPENDED BACKWALL AND COVERED DOGHOUSE FOR YOUR TANKS

**The results you can expect from SIMPLEX design are:**

Reduces dust at the charging end.

Reduces cost of mantel block replacement.

Causes batch to frit before being exposed to flame.

Eliminates large percentage of dust and prolongs life and efficiency of checkers.

Gives greater flame coverage which produces more efficient melting.

Increases life of refractories in upper structure due to less dusting.

Gives better control of the foam line.

Melts same tonnage with less fuel than is possible with conventional method of filling.

**SIMPLEX equipment always gives great satisfaction.**

## FRAZIER-SIMPLEX, INC.

## ENGINEERS

435 EAST BEAU STREET • WASHINGTON, PENNA., U. S. A.

**Abrasives**
Carborundum Co. (*Carborundum and Aloxite*)
Celo Mines, Inc. (*Almanite Garnet*)
The Hommel Co., O., Inc.
Norton Co. (*Alundum-Crystolon*)

**Air Conditioning Systems**
Frazier-Simplex, Inc.

**Aloxite (Refractory Products)**
Carborundum Co.

**Alumina (Hydrate and Calcined)**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

**Alumina (Fused) Brick and Tile**
The Vitro Mfg. Co.

**Aluminum Oxide (Calcine)**
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Aluminum Oxide (Fused)**
Carborundum Co.
Harshaw Chemical Co.
Norton Co.
The Vitro Mfg. Co.

**Alundum (Refractory Products)**
Norton Co.

**Ammonium Bicarbonate**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Solvay Sales Corp.

**Ammonium Bifluoride**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Ammonium Carbonate**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Antimony Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Antimony Sulphide**
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel Co., O., Inc.

**Arches (Interlocking, Suspending, and Circular)**
Frazier-Simplex, Inc.

**Arsenic**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.

**Automatic Brick Car Loaders**
Lancaster Iron Works, Inc.

**Ball Mills**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
McDanel Refractory Porcelain Co.
The Vitro Mfg. Co.

**Ball Mills (Laboratory Type)**
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

**Barium Carbonate**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Basic Oxides**
Porcelain Enamel and Mfg. Co.

**Batch Systems**
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.

**Batts**
Carborundum Co. (*"Carbofrax Aloxite"*)
Denver Fire Clay Co.
Norton Co. (*Alundum-Crystolon*)

**Beryl**
Foote Mineral Co.

**Bichromate of Soda**
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Bitstone**
Potters Supply Co.

**Blocks (Refractory)**
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.
The Vitro Mfg. Co.

**Body Stains**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

**Bone Ash**
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Borax**
American Potash & Chemical Corp.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

**Borax Glass**
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

**Boric Acid (Anhydrous)**
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

**Boric Acid (Crystal, Granular, or Powder)**
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

**Boron Carbide**
Norton Co.

**Brick Machines (also Barrows, Molds)**
Lancaster Iron Works, Inc.

**Brick (Refractory)**
Carborundum Co. (*"Carbofrax Aloxite"*)
Corhart Refractories Co.
Denver Fire Clay Co.
Norton Co.
The Vitro Mfg. Co.

**Cadmium Sulphide**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Carbofrax (Refractory Products)**
Carborundum Co.

**Carbonates (Barium, Lead)**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Castings**
Lancaster Iron Works, Inc.

**Castings (Abrasive Resisting)**
Bethlehem Steel Co.

**Caustic Potash**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.

**Caustic Soda**
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O. Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

**Cements**
Carborundum Co.
Corhart Refractories Co.
Norton Co.
Pennsylvania Salt Mfg. Co.

**Ceramic Chemicals**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Cerium Oxide**
Drakenfeld, B. F., & Co.
Foote Mineral Co.

**Chromite (Natural Chromate of Iron)**
Foote Mineral Co.

**Chromium Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Clay (Ball)**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

**Clay (Bentonite)**
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.

**Clay (Block)**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

**Clay (China)**
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Thomas Alabama Kaolin Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

**Clay—Cleaners, Feeders**
Lancaster Iron Works, Inc.

**Clay (Electrical, Porcelain)**
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Clay (Enamel)**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Metal & Thermit Corp.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

**Clay (Fire)**
Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Clay (German Vallendar)**
Ceramic Color & Chemical Mfg. Co.

# Advertise in The Bulletin

**Number of Insertions**

| | *1 month* | *3 months* | *6 months* | *12 months* |
|---|---|---|---|---|
| **Full page** | **$66.00** | **$60.00** | **$52.00** | **$44.00** |
| **Half page** | **36.00** | **33.00** | **30.00** | **26.00** |
| **Quarter page** | **20.00** | **18.00** | **16.50** | **15.00** |
| **Eighth page** | **10.75** | **9.90** | **9.00** | **8.25** |

**Classified advertisements: 35 words for $1.10 per insertion**

**Cover positions: list plus 25%**

**First page preceding or following reading matter: list plus 20%**

**Color rates: on application**

**Reading notices not accepted**

THE WASHING PLANT OF THE GOVERNMENT CERAMIC INDUSTRIES TRAVANCORE, INDIA

*We produce!*

FINE CERAMIC CLAYS FOR TEXTILES PAPER POTTERY

*We manufacture!*

PORCELAIN STONEWARE
ELECTRIC INSULATORS
REFRACTORIES FIRE-BRICKS AND DRAINAGE PIPES

**Government Ceramic Industries**
**Kundara, Travancore, India**

# Ceramic Service? We Give It

*We Manufacture—*

Pins—all shapes and lengths
Stilts
Thimbles
Spurs
Saggers
Crucibles
Tile for Decorating Kilns

*We Sell—*

Ball Clays—Kentucky
Sagger Clays—Kentucky
Ground Fire Clay—Ohio, Pennsylvania
Bitstone—all sizes
Fire Brick
Imported Paris White
Domestic Whiting
Georgia Kaolin
Modeling Clay

## THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

# THE MELTING CHARACTERISTICS OF PYROMETRIC CONES

THE melting characteristics of pyrometric cones depend, in large measure, upon the melting of the silicate minerals. At their melting temperature many of the silicates show very high viscosity and their melting is accompanied by a softening rather than by an abrupt passage into a liquid state.

The initial or first stage of melting is determined by the eutectic composition, and the amount of the melt formed at that temperature depends upon how much eutectic composition is in the silicate mixture.

The second stage of melting covers a range in temperature and the phenomenon involved is the solution of undissolved (or unmolten) minerals left after the eutectic has melted.

The softening depends also upon the viscosity of the melt, which in turn depends upon the composition of the minerals from which the melt has formed.

As the amount of the molten material increases, the rigidity of the mass becomes less, and the cone gradually weakens and softens, deforming in the characteristic way.

**California Representative**
**E. L. Maxson**
**112 W. 9th St.**
**Los Angeles, Calif.**

**South American Representative**
**The Ferro Enamel Corp.**
**4150 E. 56th St.**
**Cleveland, Ohio**

**THE EDWARD ORTON, JR., CERAMIC FOUNDATION**
**1445 SUMMIT STREET COLUMBUS, OHIO**

**THE HOUSE OF HOMMEL**
**SUPPLIERS OF ALL CERAMIC NEEDS**

*Quality*
**FRITS**
**COLORS**
**CHEMICALS**
**Stocked for**
***IMMEDIATE SHIPMENT***

**THE**
**O. HOMMEL CO.**
*Quality First - Since 1891*
209 Fourth Avenue Pittsburgh, Pa.
LET OTHERS IMITATE -:- WE ORIGINATE

*Pacific Coast Agents*
**L. H. BUTCHER CO.**
Los Angeles - Salt Lake City - San Francisco - Portland - Seattle

# JOURNAL OF THE SOCIETY OF GLASS TECHNOLOGY

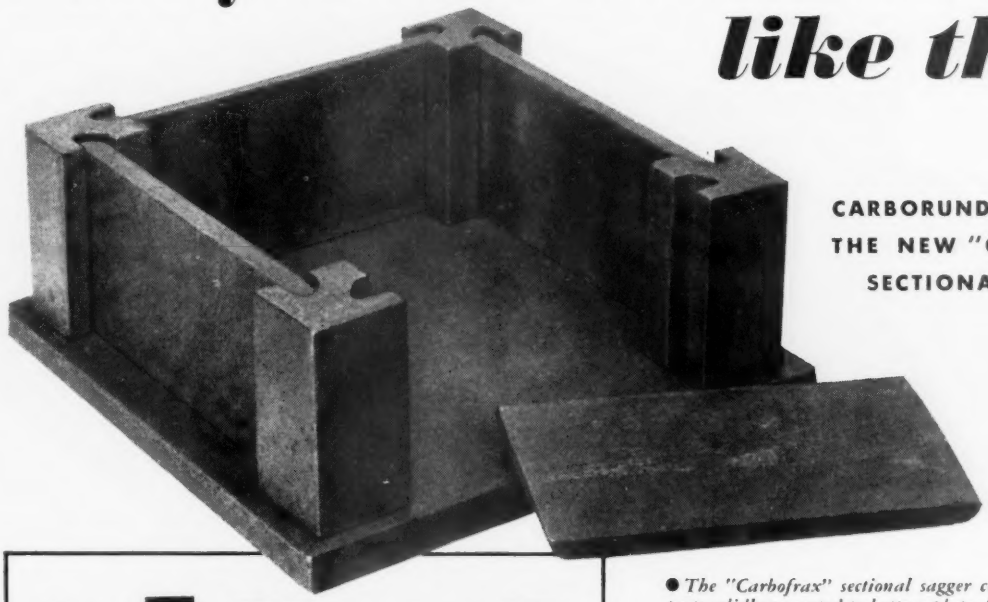
A bimonthly Journal containing the original papers communicated to the Society together with abstracts of other papers covering the whole field of glass technology.

Membership of the Society is open to all persons, or associations of persons, interested in glass.

*Orders and enquiries should be addressed to—*

**The Secretary,**
**Society of Glass Technology,**
**The University,**
**"Elmfield," Northumberland Road,**
**SHEFFIELD, 10, England.**

# Have you ever seen a SAGGER *like this?*



**CARBORUNDUM PRESENTS THE NEW "CARBOFRAX" SECTIONAL SAGGER**

● *The "Carbofrax" sectional sagger consists of four posts solidly cemented to bottom plate, four removable side pieces and, if desired, a center tray.*

● *"Carbofrax" sectional sagger used for open setting. Top sagger is set with larger pieces. The center saggers with center tray in place, have an excellent fill of smaller ware. The lower section with side pieces in place is filled with very small ware. Flexibilty of operation and economical fill are important advantages of this new sagger.*

● *"Carbofrax" sectional sagger used in sagger setting, for firing of large number of small pieces.*

EXHAUSTIVE field tests prove that this new type of sagger has FOUR important advantages:

**1. LONGER LIFE** because its sectional construction offers greater resistance to heat shock than the one-piece type.

**2. READILY CONVERTIBLE** because its easily inserted center tray permits its use for a wide variety of different size ware.

**3. INCREASED FLEXIBILITY OF OPERATION** because its removable sides make it usable as a regular sagger or in open settings. It offers an excellent fill for all types of ware.

**4. HIGHER REFRACTORINESS AND LONGER LIFE** because it's made of **"CARBOFRAX"**, the Carborundum Brand Silicon Carbide Refractory.

Get in touch with our nearest listed representative this week and see how you can reduce your firing costs with this new type sagger.

**REFRACTORY DIVISION**

**THE CARBORUNDUM COMPANY**

REG. U. S. PAT. OFF.

*Perth Amboy, N. J.*

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Distributors: McConnell Sales and Engineering Corporation, Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles, San Francisco; Denver Fire Clay Co., El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.

(Carborundum and Carbofrax are registered trade-marks of and indicate manufacture by The Carborundum Company)

# FORTY-THIRD ANNUAL MEETING, AMERICAN CERAMIC SOCIETY

## BALTIMORE, MARYLAND, MARCH 30 to APRIL 5, 1941

**Headquarters and Meetings in Lord Baltimore Hotel with Guaranteed Rooms Available in Hotels Emerson, Southern, Maryland, New Howard, and Belvedere**

••• *Baltimore* •••

THE GASTRONOMIC METROPOLIS OF THE UNION

# *The Best West of the Rockies*

- **POTTERY CLAYS**
  English and American
- **CERAMIC COLORS**
  Blythe Colour Works, Ltd.
- **SLABS...SETTERS...SAGGERS**
  New Castle Refractories Co.
- **STANDARD PYROMETRIC CONES**
  Edward Orton, Jr., Ceramic Foundation
- **FRANTZ FERROFILTERS**
- **LAKEFIELD NEPHELINE SYENITE**
  Great Lakes Foundry Sand Co.

## ELWYN L. MAXSON

112 W. 9TH ST. *Ceramic Materials* LOS ANGELES

PAPER MAKERS IMPORTING CO., INC. EASTON, PENNSYLVANIA, U.S.A. PMI INC

HIGHEST QUALITY
IMPORTED AND DOMESTIC

# CLAYS

FLINT TALC
WHITING

PRECIPITATED CALCIUM CARBONATE

Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Clay (Micronized)**
Porcelain Enamel and Mfg. Co.

**Clay Miners**
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Clay (Potters)**
Denver Fire Clay Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Clay (Process Equipment)**
Lancaster Iron Works, Inc.
National Engineering Co.

**Clay (Sagger)**
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Clay-Slip (Albany)**
Hammill & Gillespie, Inc.
United Clay Mines Corp.

**Clay (Wad)**
Kentucky Clay Mining Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Albama Kaolin Co.
United Clay Mines Corp.

**Clay (Wall Tile)**
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

**Cleaners**
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.

**Cleaners, Chemical**
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

**Clocks (Gauge Board)**
The Hommel Co., O., Inc.

**Cobalt Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Cobalt Sulphate**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Colors**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Cones**
The Edward Orton, Jr., Ceramic Foundation

**Conveying Equipment**
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.

**Copper Oxide**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Corhart**
Corhart Refractories Co.

**Cornwall Stone (Imported)**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

**Crucibles (Filter, Melting, Ignition)**
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Potters Supply Co.

**Crushers (Clay)**
Lancaster Iron Works, Inc.

**Cryolite (see Kryolith)**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

**Crystolon (Refractory Products)**
Norton Co.

**Cullet, Washing Plants, Incinerators, Crushers**
Frazier-Simplex, Inc.

**Cutters (Bar)**
Industrial Ceramic Products, Inc.

**Decorating Supplies**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Disintegrators**
Lancaster Iron Works, Inc.
National Engineering Co.

**Dryer (Pipe Rack)**
Lancaster Iron Works, Inc.

**Drying Machinery**
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.

**Electrocast Refractories**
Corhart Refractories Co.

**Enamelers' Borax**
Porcelain Enamel and Mfg. Co.

**Enameling Equipment (Complete)**
Ceramic Color & Chemical Mfg. Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

**Enameling Furnaces**
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Lancaster Iron Works, Inc.
Norton Co.

**Enameling Iron (Sheet)**
American Rolling Mill Co.
Bethlehem Steel Co.

**Enameling Muffles**
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Frazier-Simplex, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co. (*Alundum*)

**Enameling (Practical Service)**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Enamels**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Enamel Oxide**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

**Enamels (Porcelain)**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Equipment (Porcelain Enameling)**
Ceramic Color & Chemical Mfg. Co.
The DeVilbiss Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.

**Exhaust Systems**
The DeVilbiss Co.

**Feldspar**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Filter Fabrics**
Metakloth Company

**Fire Brick**
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Norton Co.

**Fire Brick—Process Equipment**
Lancaster Iron Works, Inc.

**Fire Clay**
Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.

**Flint**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Great Lakes Foundry Sand Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.

**Flint Pebbles**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

**Floors (Non-Slip)**
Norton Co.

**Fluorspar**
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**French Flint**
Maxson, Elwyn L.
Paper Makers Importing Co.

**Frit**
Ceramic Color & Chemical Mfg. Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Frosting Mixtures**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Fuel Oil Systems and Control, Stokers**
Bethlehem Steel Co.
Frazier-Simplex, Inc.

**Furnaces**
Carborundum Co. (*Carboradiant*)
Denver Fire Clay Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Swindell-Dressler Corp.

**Furnaces, Enameling**
Swindell-Dressler Corp.

**Glass Bending Ovens, Glass Decorating Machines**
Frazier-Simplex, Inc.

**Glass Equipment**
Hartford-Empire Co.
Lancaster Iron Works, Inc.

**Glass Melting Tanks and Furnaces**
Frazier-Simplex, Inc.

**Glass Sand**
Great Lakes Foundry Sand Co.

**Glass Thickness Gauge**
Bausch & Lomb Optical Co.

**Glaze and Body Spar**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Glazes and Enamels**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.

THE SHARP-SCHURTZ COMPANY

CHEMISTS FOR THE CERAMIC INDUSTRY

WE HAVE FULLY EQUIPPED LABORATORIES AT

LANCASTER, OHIO U. S. A.

EMERSON P. POSTE

CONSULTING CHEMICAL ENGINEER

ANALYSES: CERAMIC RAW MATERIALS AND PRODUCTS, FUELS, IRON AND STEEL, ETC.

SPECIAL INVESTIGATIONS: PHYSICAL AND CHEMICAL TESTS ON ENAMEL, ETC.

309 McCALLIE AVE.,
CHATTANOOGA, TENN.

99 1/2 % PURE KAOLINITE

"Properly Priced for Very Large Users"

*Write for Information and Samples*

P. C. E. CONE 35

THE THOMAS ALABAMA KAOLIN CO.

2412 Ken Oak Road, Baltimore, Md.

Mines: Chalk Bluff, Ala. Processing Plant: Hackleburg, Ala.

| | | |
|---|---|---|
| Analysis | Loss on ignition | 13.89% |
| | Silica ($SiO_2$) | 44.74 |
| | Aluminum oxide ($Al_2O_3$) | 39.47 |
| | Titanium oxide ($TiO_2$) | 1.29 |
| | Ferric oxide ($Fe_2O_3$) | 0.55 |
| | Lime (CaO) | 0.00 |
| | Magnesia (MgO) | 0.00 |
| | Alkalis ($Na_2O, K_2O$) | 0.00 |
| Mechanical Composition | —20 microns | 98.00% |
| | —10 " | 80.98 |
| | — 6 " | 70.94 |
| | — 3 " | 54.70 |
| | — 1 " | 37.74 |
| | — 0.5 " | 21.75 |

CERAMITALC

REGISTERED IN U. S. PATENT OFFICE

SPECIAL TALC for CERAMIC BODIES

INTERNATIONAL PULP CO.

41 PARK ROW LIBERAL SAMPLES FREE NEW YORK

*All Types of Circular and Straight Tunnel Kilns*

SWINDELL-DRESSLER CORPORATION

**Post Office Box 1888** **Pittsburgh, Pa.**

***Lehrs and Enameling Furnaces, Electric and Gas Fired***

*Full Details Furnished on Request*

KILN ROOM REQUISITES OF

*Ceramic Specialists* SINCE 1901

DINNERWARE SETTERS & RINGS
TILE SETTER PINS
THIMBLES
FIRING RACKS
PINS • STILTS • SPURS
SPECIALTIES

LOUTHAN HI-FIRE *Refractories*

THE LOUTHAN MANUFACTURING COMPANY

NEW YORK EAST LIVERPOOL, OHIO, U. S. A. LOS ANGELES

INDUSTRIAL CERAMIC PRODUCTS, Inc.

*MANUFACTURERS*

PINS COLUMBUS, OHIO STILTS

Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Glaze Spar**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

**Goggles**
The Hommel Co., O., Inc.

**Gold**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Gold Decorations**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

**Granulators**
Lancaster Iron Works, Inc.

**Grinding Wheels**
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

**Hearths**
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Norton Co. (*Crystolon*)

**Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)**
Carborundum Co.
Norton Co.

**Hose (Air and Fluid)**
The DeVilbiss Co.

**Hydrofluoric Acid**
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Iron Chromite**
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.

**Iron (Enameling)**
American Rolling Mill Co.
Bethlehem Steel Co.

**Iron Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Kaolin**
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

**Kilns, China (Decorating)**
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

**Kilns-(Electric, Circular, Tunnel)**
Swindell-Dressler Corp.

**Kiln Furniture (Silicon Carbide, Semi-Silicon carbide) (Refractory)**
Louthan Mfg. Co.

**Kyanite**
Celo Mines, Inc.

**Kryolith (see Cryolite)**
Pennsylvania Salt Mfg. Co.

**Laboratory Ware**
Norton Co.

**Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)**
Carborundum Co.

**Lehrs**
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

**Lehrs (Electric or Fuel Heated)**
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

**Lehr Loaders**
Frazier-Simplex, Inc.

**Linings (Furnace Refractory, Block Refractory Plate, Brick, and Tile)**
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.
The Vitro Mfg. Co.

**Lithium Carbonate**
Drakenfeld, B. F., & Co.
Edgar Plastic Kaolin Co.
Foote Mineral Co.

**Lithium Minerals**
Foote Mineral Co.

**Loaders (Bucket)**
National Engineering Co.

**Magnesia (Fused)**
Norton Co.

**Magnesia (Sintered, Calcined)**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.

**Magnesite**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Magnesite Calcined**
Foote Mineral Co.
The Hommel Co., O., Inc.

**Magnesium Carbonate**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Manganese**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Manganese Dioxide**
Drakenfeld, B. F., & Co.
Edgar Plastic Kaolin Co.
Foote Mineral Co.

**Manganese (Oxide)**
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Masks (Breathing)**
The DeVilbiss Co.
Drakenfeld, B. F., & Co.

**Metals (Porcelain Enameling)**
American Rolling Mill Co.
Bethlehem Steel Co.

**Micronized Products**
Porcelain Enamel and Mfg. Co.

**Microscopes (Polarizing)**
Bausch & Lomb Optical Co.
Spencer Lens Co.

**Microscopes (Stereoscopic)**
Spencer Lens Co.

**Minerals**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Mixers**
National Engineering Co.

**Mixers (Batch)**
Lancaster Iron Works, Inc.
National Engineering Co.

**Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)**
Lancaster Iron Works, Inc.

**Mixers (Laboratory)**
Lancaster Iron Works, Inc.
National Engineering Co.

**Mold Sanders**
Lancaster Iron Works, Inc.

**Muffles (Furnace) (Laboratory)**
Carborundum Co. (*Carbofrax*)
Denver Fire Clay Co.
Frazier-Simplex, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

**Mullers (Batch)**
Lancaster Iron Works, Inc.
National Engineering Co.

**Muriatic Acid**
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

**Needle Antimony**
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Nepheline Syenite**
Great Lakes Foundry Sand Co.

**Nickel Salts**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Nitrates (Cobalt, Sodium)**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Nitre**
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Norbide (Norton Boron Carbide)**
Norton Co.

**Olivine**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

**Opacifiers**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Overglaze Colors**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

**Oxides**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Palladium Decorations**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

**Pins**
The Hommel Co., O., Inc.
Industrial Ceramic Products, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Louthan Mfg. Co.
Potters Supply Co.

**Pins (Tile Setter)**
Louthan Mfg. Co.

**Placing Sand**
Great Lakes Foundry Sand Co.
United Clay Mines Corp.

**Platinum Decorations**
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

**Polariscopes**
Bausch & Lomb Optical Co.
Frazier-Simplex, Inc.

**Porcelain Enameling Service (Practical)**
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Porcelain Enamels**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Potters Wheels**
Denver Fire Clay Co.

**Potash (Carbonate)**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.

"Ceramic"
Colors
AND
Chemicals

WENNING CERAMIC COLORS TRADE MARK

for POTTERY
· GLASS
· ENAMEL

See our catalog in Ceramic Data Book

CERAMIC COLOR AND CHEMICAL MFG. CO.
New Brighton, Pa., U. S. A.

Bethlehem Products
for the Ceramic Industry

88-80 CASTINGS
to save maintenance on grinding equipment

BETHLEHEM ABRASIVE-RESISTING PLATES
for chutes, hoppers, dump-car bottoms

BETHLEHEM TOOL STEEL
for dry press and repress liners

BETH-CO-LOY SHEETS
for long-lasting roofing and siding

WIRE ROPE
for all excavating and material-handling equipment

Also—Light Rails, Steel Ties and Track Equipment, Steel Pipe

BETHLEHEM STEEL COMPANY
General Offices BETHLEHEM STEEL Bethlehem, Pa.

This nameplate on the furnace means satisfaction on the job—

The DENVER FIRE CLAY Company
EL PASO, TEXAS · NEW YORK, N.Y. · DFC · SALT LAKE CITY, UTAH
DENVER, COLO., U. S. A.

DFC P.C.E. Furnace

American Refractories Institute Type

PORTABLE—
Weight, 125 lbs., height 22½", floor space required 18" x 22".

CONVENIENT—
Can be operated on artificial or natural gas, or propane.

EFFICIENT—
Accurate in control tests of the Pyrometer Cone Equivalent. Cone 34 can be brought down with a mixture of gas and air or, by introduction of a small amount of oxygen, temperatures up to Cone 39 can be obtained.

*Write for Bulletin No. 460*

The DENVER FIRE CLAY Company
EL PASO, TEXAS · NEW YORK, N.Y. · DFC · SALT LAKE CITY, UTAH
DENVER, COLO., U. S. A.

The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

**Producer Glass Plants**
Frazier-Simplex, Inc.

**Pug Mills**
Lancaster Iron Works, Inc.

**Pyrites (Natural Iron Sulphide)**
Foote Mineral Co.
The Hommel Co., O., Inc.

**Pyrometer Tubes**
Carborundum Co.
Montgomery Porcelain Products Co.

**Pyrometer Tubes (Refractory and Hard Porcelain)**
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

**Pyrometers (Optical, Radiation, Surface, Immersion, Needle)**
Leeds & Northrup Co.
Pyrometer Instrument Co.

**Pyrometric Cones**
The Edward Orton, Jr., Ceramic Foundation

**Racks, Firing (Refractory)**
Louthan Mfg. Co.

**Raw Material Handling Equipment**
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

**Refractometers**
Bausch & Lomb Optical Co.
Spencer Lens Co.

**Refractories**
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.

**Refractory Materials**
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.
Thomas Alabama Kaolin Co.

**Respirators**
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.

**Rutile**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Foote Mineral Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

**Saggers**
Carborundum Co.
Norton Co.
Potters Supply Co.

**Salt Cake**
American Potash & Chemical Corp.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

**Sandblast Sand**
Great Lakes Foundry Sand Co.

**Sand Grinder and Sifters**
Lancaster Iron Works, Inc.

**Saponin**
The Hommel Co., O., Inc.

**Screening and Magnetic Separators**
National Engineering Co.

**Selenite of Sodium**
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Selenium**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Setters (Tableware)**
Louthan Mfg. Co.

**Sheets (Enameling Iron)**
American Rolling Mill Co.
Bethlehem Steel Co.

**Silica (Fused)**
Edgar Plastic Kaolin Co.
The Hommel Co., O., Inc.

**Silicate of Soda**
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Silicon Carbide**
Carborundum Co.
Norton Co.

**Silicon Carbide Firesand**
Carborundum Co.

**Sillimanite Refractories**
Denver Fire Clay Co.

**Slabs (Furnace)**
Carborundum Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

**Soda Ash**
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

**Sodium Antimonate**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

**Sodium Fluoride**
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Sodium Metasilicate**
Harshaw Chemical Co.

**Sodium Nitrite**
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Sodium Silica Fluoride**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Sodium Uranate**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Soot Blowers**
Frazier-Simplex, Inc.

**Special Machines**
Frazier-Simplex, Inc.

**Spar**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Vitro Mfg. Co.

**Spray Booths**
The DeVilbiss Co.
The Hommel Co., O., Inc.

**Spraying Equipment**
The DeVilbiss Co.
The Hommel Co., O., Inc.

**Spurs**
Louthan Mfg. Co.
Potters Supply Co.

**Stacks**
Lancaster Iron Works, Inc.

**Steel Plate Construction**
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

**Stilts**
The Hommel Co., O., Inc.
Industrial Ceramic Products, Inc.
Louthan Mfg. Co.
Potters Supply Co.

**Sulfuric Acid**
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

**Talc**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
International Pulp Co.
Paper Makers Importing Co.

**Tanks**
Frazier-Simplex, Inc.

**Tank Blocks**
Corhart Refractories Co.

**Tanks (Pickle)**
The Hommel Co., O., Inc.

**Tanks for Raw Material Steel or Concrete**
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

**Tile (Floor)**
Norton Co.

**Tile (Muffle)**
Carborundum Co.
Norton Co.

**Tile Setter Pins**
Louthan Mfg. Co.

**Tile (Refractory)**
Carborundum Co. (*Carbofrax*)
Denver Fire Clay Co.
Norton Co.
Thomas Alabama Kaolin Co.

**Tile (Wall)**
Denver Fire Clay Co.
Thomas Alabama Kaolin Co.

**Tin Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

**Titanium**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Titanium Oxide**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

**Trisodium Phosphate**
Harshaw Chemical Co.

**Trucks**
Lancaster Iron Works, Inc.

**Tubes (Insulating)**
Carborundum Co.
Louthan Mfg. Co.
McDanel Refractory Porcelain Co.
Norton Co.

**Tubes (Pyrometer)**
Carborundum Co.
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

**Uranium Oxide**
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

**Uranium Oxide (Yellow-Orange-Black)**
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Water Softening Plants**
Frazier-Simplex, Inc.

**Wet Enamel**
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

**Whiting**
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

**Winding Drums**
Lancaster Iron Works, Inc.

**Zinc Oxide**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

**Zircon**
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel Co., O., Inc.

**Zirconia**
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

**Zirconium Oxide**
Foote Mineral Co.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.

**Zirkite (Natural $ZrO_2$)**
Foote Mineral Co.

# BLACK 4492

DU PONT
REG. U.S. PAT. OFF.

## offers a New–Low-Cost BLACK OXIDE for Enameling

● *Improved low-cost black oxide for sheet steel and cast iron enameling*

AFTER months of intensive research, du Pont has now made available an improved black oxide—Black 4492. It is similar in type to Black 4490 but it has a number of outstanding advantages over this product such as:

*Increased strength*—30% stronger than du Pont Black 4490.

*Intense color*—The deep black is equal to, and in many cases superior in intensity to, any black oxide now in commercial use.

*Low cost*—The price is lower than any other black oxide of equal depth of tone.

*Economy*—Because it is 30% stronger than Black 4490, less of 4492 is needed to produce identical color depth, making possible a substantial saving in material costs. By using the same amount of 4492 in 4490 formulations, the quality of enameled products can be improved at no increase in cost, for 4492 is offered at the same price as 4490.

Black 4492, like other du Pont products, has been thoroughly tested commercially. It can be depended upon to give consistently good results over a wide range of operating conditions.

Further information about this product—prices, etc.—can be obtained by writing to any of the R. & H. District Offices listed below or to the Chicago Vitreous Enamel Product Company, Chicago, Illinois.

★ ★ ★

*Visit the du Pont Wonder World of Chemistry Exhibits at the New York World's Fair and on the Boardwalk at Atlantic City*

DU PONT
REG. U.S. PAT. OFF.

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
The R. & H. Chemicals Department
Ceramics Division Wilmington, Delaware
District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

# COMPLETE MEMBERSHIP ROSTER

.....

## WILL BE PUBLISHED IN THE OCTOBER BULLETIN

This ROSTER will be the "Who's Who" of Ceramic Technology; therefore, the name of every ceramist should be listed.

Advertising will be especially effective in the October Bulletin because the circulation will be greatly increased and because this Roster will be referred to constantly.

*For advertising rates see page 13*

**AMERICAN CERAMIC SOCIETY**
2525 N. HIGH ST. COLUMBUS, OHIO

# "CONTROLLED MIXING"

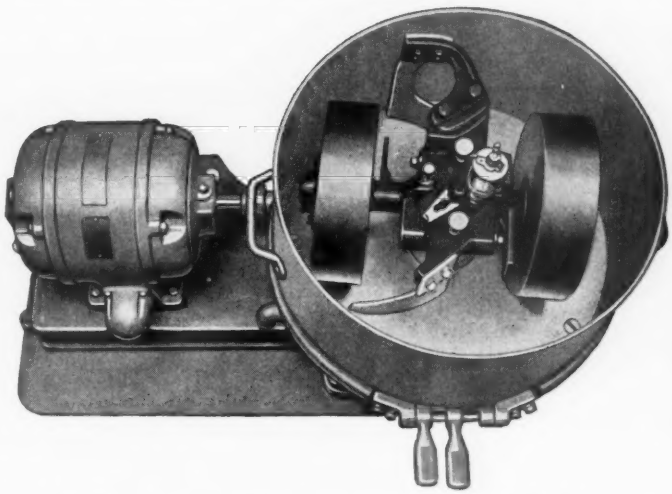
of ceramic bodies
by mulling in the

## SIMPSON INTENSIVE MIXER

Progressive plants in all branches of the ceramic and refractory industries are securing important advantages and major production economies with inexpensive, flexible and closely controlled procedures in the preparation of their materials for forming.

It will pay you to investigate "controlled mixing" for your products, with the genuine muller-type Simpson Intensive Mixer recommended for this work.

Our Ceramic Engineer is available on request and will be glad to discuss your special requirements thoroughly and without obligation.



Laboratory size Simpson Intensive Mixer, equipped with removable crib, crosshead and mullers. The standard machine for test and control work on ceramic and refractory materials.

Manufactured by

## NATIONAL ENGINEERING COMPANY

549 W. Washington Blvd., Chicago, Illinois, U. S. A.

Manufacturers and Selling Agents for Continental European Countries—The George Fischer Steel & Iron Works, Schaffhausen, Switzerland
For the British Possessions, excluding Canada and Australia—August's Limited, Halifax, England
For Canada—Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand—Gibson, Battle & Co., Pty., Ltd., Sydney, Australia

## BORAX *Guaranteed 99½%–100% Pure* BORIC ACID

**Select the Brand which has back of it years of *successful use* by experienced Ceramists**

## Pacific Coast Borax Co., New York

Chicago 20 Los Angeles

# BACK NUMBERS
OF
## JOURNAL OF AMERICAN CERAMIC SOCIETY
AND ALL IMPORTANT MAGAZINES FROM THE WORLD OVER

We furnish single copies, volumes, or sets reasonably and promptly

WRITE, PHONE OR WIRE PERIODICALS DEPARTMENT

THE H. W. WILSON COMPANY 950 University Avenue, New York

# CRYSTOLON KILN FURNITURE

*Is Saving Users Money*

*for Two Specific Reasons . . .*

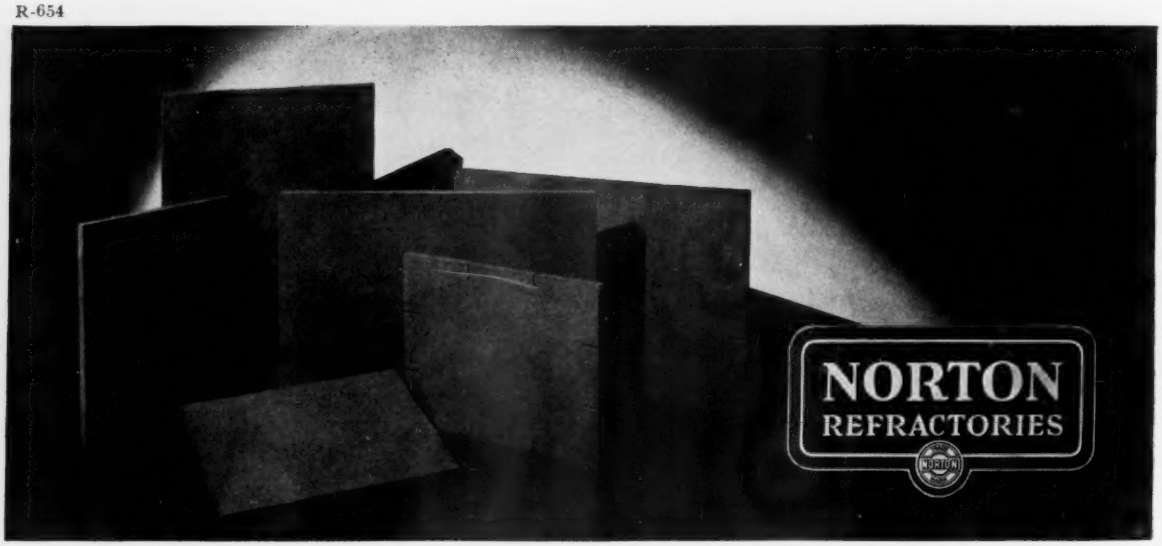
1. It increases kiln capacity
2. It has long life

Bulky kiln furniture is expensive to carry through a tunnel kiln because every cubic inch that furniture occupies in the kiln means just that much less room for salable products.

Crystolon Kiln Furniture—Batts, Saggers, Supports—made of highly refractory Norton silicon carbide, resists deformation and growth. It is so strong that it can be used in very thin cross-section. The slotted batt is an exclusive Norton feature.

NORTON COMPANY, WORCESTER, MASS.
New York Chicago Cleveland

R-654



H. C. SPINKS CLAY COMPANY

Miners and Shippers of

BALL, SAGGER AND WAD CLAY

NEWPORT, KY.

Puryear, Tennessee
August 1, 1940

Mr. Pete Potter
Comfortable Sanitary Pottery Mfg. Co.
Pottsville, U. S. A.

Dear Pete:

It seems almost certain that there will be a good volume of business available for all of us during the balance of this year.

Well, the busier we are down here the smoother the outfit seems to run. And we are trying harder than ever to not only maintain but improve the quality and uniformity of our Ball Clays.

We hope that the quality of our clays and our service will express to you our appreciation of your patronage.

Sincerely,

Dick Carothers

General Manager
H. C. SPINKS CLAY COMPANY

P.S.: When you are real busy is when you need only the best BALL CLAYS.

# M and T TIN OXIDE

Brilliant . . . rich . . . snow-white . . . free of specks and discolorations . . . that's the kind of glaze you want, and that's the kind you will get consistently with M & T Tin Oxide.

Hundreds of important firms have standardized on the use of M & T Tin Oxide because it assures, at an advantageous price, the superior results they demand.

**METAL & THERMIT CORPORATION**

120 BROADWAY

NEW YORK